Selbyana 31(1): 5–39. 2013.

A Guide to the Morphology of the Pollinia and Pollinaria of Orchids from the Biological Corridor Tacaná-Boquerón in Southeast Mexico

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Abstract. We continue to document the morphology of the pollinaria of the orchids of southeast Mexico, this time concentrating on 56 species from the Tacaná-Boquerón biological corridor, a recognized biodiversity "hotspot." This study is a component part of the project "Ecology and sustainable cultivation of orchids of Soconusco," which aims to conserve and restore the orchid populations of this biodiverse region.

Key words: epiphytic orchids, terrestrial orchids, Soconusco, biodiversity "hotspot", orchid pollination, conservation

Introduction

We continue to analyze the morphology of the orchids of Soconusco, in the state of Chiapas in southeast Mexico, and to expand our image and data base for taxonomic purposes and to facilitate the identification of pollinaria found adhered to the bodies of pollinators. This paper is a sequel to Nieto & Damon (2008) and describes the morphology of 56 species of orchids growing in the Biological Corredor Tacaná-Boquerón, in the southeastern tip of Mexico, which is one of the most orchid species-rich regions in Mexico and connects with the Central American Biological Corridor. Most of these species included in this second paper are found growing at altitudes above 2000 m within pine-oak and cloud forest habitats. A third and final study is contemplated which will then include the rest of the surviving and available orchid species of the Soconusco region, and will include a detailed discussion relating to all the species covered.

Singer (2008) discussed the general characteristics of orchid flowers and pollinaria and emphasized the importance of image databases and DNA analyses of orchid pollinaria for pollination studies and species identification. He also emphasized the importance of sharing image databases of orchid pollinaria, hence the publication of this further set of 56 species, before concluding the study of the pollinaria of the orchids of the Soconusco region of southeast Mexico, which comprises close to 300 species (Solano & Damon, unpubl. data).

As described in Nieto and Damon (2008), one of the determining characteristics of the vast majority of orchid species is the grouping of the entire production of pollen grains of every flower into 2 or more discrete masses, termed pollinia, with two or more of these combined into a structure called the pollinarium. True pollinia and pollinaria are restricted to two of the five orchid subfamilies, Orchidoideae and Epidendroideae. The pollinarium consists of, not only the pollen masses (pollinia), but also the supporting structures and secretions that connect them to the anther and facilitate the transport of the pollinarium by animal pollinators (Singer 2008). All Angiosperms produce flowers with four pollen sacs, and orchids are no exception, with the basic number of pollinia per pollinarium also four, although this number has been secondarily increased or decreased in some species. Structurally different, but functionally similar pollinaria and pollinia are found in a few other plant groups, particularly Asclepiadoideae and Periplocoideae, which are subfamilies of Apocynaceae. The types, taxonomic features and phylogenetic relationships of the pollinaria found in Orchidaceae are described by Singer (2008), whereas aspects of development, structure, function, adaptation and evolution are amply covered by Johnson and Edwards (2000). A detailed description of orchid flower structure, the column, anther and stigma can be found in Dressler (1993).

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TABLE 1. List of orchid species studied, with flowering dates and collection data.

Species	Flowering date	Collection site	Project collection no.	Accession number living collection or no. herbarium (Voucher)
Subfamily Orchidoideae				
Tribe Cranichideae				
Subtribe Spiranthinae				
Cyclopogon sp.	5 March 2008	BB		MEXU! 92
Dichromanthus aurantiacus La Llave & Lex.) Salazar & Soto Arenas	8 July 2008	BB		*728
Pelexia funkiana A. Rich. & Galeotti) Schltr.	24 November 2007	M		*626
Stenorrhynchos speciosum (Jacq.) Rich. ex Spreng.	12 October 2007	BB-V		*598
Schiedeella jean-mulleri Szlach., Rutk. & Mytnik	24 November 2007	M		*611
Subtribe Calypsoeae				
Govenia mutica Rchb. f.	25 November 2007	M		*631
Subtribe Goodyerinae				
Goodyera striata Rchb. f.	26 November 2007	M	LJB154, LJB159	OAX OAX LJB154, LJB159
Subtribe Orchidinae				
Habenaria odontopetala (Rchb. f.) L.O. Williams	Data lost	BB		*750
Subfamily Epidendroideae				
Subtribe Bletiinae				
Bletia purpurea (Lam.) DC.	3 March 20008	BB	LJB214 LJB215	OAX OAX, LBJ 214 ECOSUR-TAP 000289
Tribe Epidendreae				
Subtribe Ponerinae				
Isochilus aurantiacus Hamer & Garay	1 July 2008	no data	LJB295 LJB295	OAX OAX LJB295 ECOSUR-TAP 000339
Isochilus chiriquensis Schltr.	13 August 2008	BB		*729
Subtribe Laeliinae				
Arpophyllum medium Rchb. f.	25 November 2007	M	LJB118 LJB118	OAX OAX LJB118 ECOSUR-TAP 000251
Barkeria spectabilis Bateman ex Lindl.	11 July 2008	Mot	LJB293	OAX OAX LJB293
Chysis bractescens Lindl.	15 February 2008	P		*680
Epidendrum cnemidophorum Lindl.	23 November 2007	M		*602
Epidendrum culmiforme Schltr.		BB		*693
Epidendrum dixorum Hágsater	2 September 2008	BB		*741
Epidendrum eximium L. O. Williams	6 May 2009	BB		*800
Epidendrum parkinsonianum Hook	10 March 2008	Mot		*656
Epidendrum radicans pav. ex Lindl.	4 May 2008	FM	LJB250 LJB250	OAX OAX LJB250 ECOSUR-TAP 000321

TABLE 1. Continued.

Species	Flowering date	Collection site	Project collection no.	Accession number living collection or no. herbarium (Voucher)
Epidendrum sobralioides Ames & Correll	23 November 2007	M	LJB96	OAX OAX LJB96
Prosthechea brassavolae (Rchb. f.) W. E. Higgins	2 March 2008	BB		*720
Prosthechea varicosa (Lindl.) W. E. Higgins	25 November 2007	M	LJB140 LJB148	OAX OAX LJB140 ECOSUR-TAP 000243
Prosthechea vitelina (Lindl.) W. E. Higgins	10 March 2008	Mot		*804
Tribe Epidendreae				
Subtribe Pleurothallidinae				
Anathallis dolichopus (Schltr.) Pridgeon & M. W. Chase	11 July 2008	AC	LJB145 LJB259	OAX OAX LJB145 ECOSUR-TAP 000244
Lepanthes acuminata subsp. *acuminata* Schltr.	24 November 2007	M	LJB130 LJB131	OAX OAX LJB130 ECOSUR-TAP 000246
Masdevallia tuerckheimii Ames	9 December 2009	BJ		*856
Pleurothallis leucantha Schltr.	23 November 2008 and 13 August 2008	M BB		*762
Pleurothallis matudana C. Schweinf.	29 November 2007 and 1 March 2008	M BB	LJB149 LJB149	OAX OAX LJB149 ECOSUR-TAP 000352
Pleurothallis nelsonii Ames	29 November 2007	2007	LJB93 LJB93	OAX OAX LJB93 ECOSUR-TAP 000351
Pleurothallis pansamalae Schltr.	2 May 2008	LP		*713
Pleurothallis saccatilabia C. Schweinf.	2 May 2008	LP		*721
Specklinia fuegi (Rchb. f.) R. Solano & Soto Arenas	24 November 2007	M	LJB102 LJB100	OAX OAX LJB102 ECOSUR-TAP 000262
Specklinia segregatifolia (Ames & C. Schweinf.) R. Solano & Soto Arenas	9 April 2009	FLJ		*784
Stelis hymenantha Schltr.	October 2008	BJ		*759
Stelis megachlamys subsp. *megachlamys*	30 May 2008	BJ		*633
Stelis tacanensis R. Solano & Soto Arenas	11 June 2008	BB		*646
Stelis vespertina R. Solano & Soto Arenas	25 March 2008	BB-EN		*639
Stelis villosa (Knowles & Westc.) Pridgeon & M. W. Chase	23 November 2009 March 2008	M BB-EN		*631
Tribe Cymbidiae				
Subtribe Oncidiinae				
Cyrtochiloides ochmatochila (Rchb. f.) N. H. Williams & M.W. Chase	25 August 2008	LP		*734
Oncidium oliganthum (Rchb. f.) L. O. Williams	1 March 2008	BB		*728
Plectrophora alata (Rolfe) Garay	2 May 2008	LP		*719

TABLE 1. Continued.

Species	Flowering date	Collection site	Project collection no.	Accession number living collection or no. herbarium (Voucher)
Rhynchostele cordata (Lindl.) Soto Arenas & Salazar	7 Febrero 2008	M	LJB138 LJB137	OAX OAX LJB138 ECOSUR-TAP 000065
Rhynchostele pygmaea (Lindl.) Rchb. f.	26 November 2007	M	LJB160 LJB160	OAX OAX LJB160 ECOSUR-TAP LJB160
Rhynchostele uroskinneri (Lindl.) Soto Arenas & Salazar	13 August 2008	BB	LJB189 LJB188	OAX OAX LJB189 ECOSUR-TAP 000404
Rossioglossum grande (Lindl.) Garay & G. C. Kenn	12 October 2009	Ber		*841
Trichocentrum bicallosum (Lindl.) M. W. Chase & N. H. Williams	30 November 2007 and 1 June 2008	M BV		*628 *721
Tribe Zygopetalinae				
Dichaea muricatoides Hamer & Garay	1 May 2008	SR	LJB221 LJB221	OAX OAX LJB221 ECOSUR-TAP 000292
Tribe Maxillarinae				
Lycaste sp.	12 August 2008		LJB220	OAX OAX LJB220
Lycaste cruenta (Lindl.) Lindl.	8 July 2008	PeN		*726
Maxillaria atrata Rchb. f.	25 November 2007	M	LJB294	OAX OAX LJB294 *600
Maxillaria houtteana Rchb. f.	5 March 2009	P	LJB192	OAX OAX LJB192
Maxillaria meleagris Lindl.				
Maxillaria soconuscana Breedlove & Mally	26 November 2007	M	LJB147	OAX OAX LJB147 *622
Tribe Stanhopeinae				
Stanhopea graveolens Lindl.	27 November 2007	M		*639
Subfamily Vandae				
Tribe Angraecinae				
Campylocentrum microphyllum Ames & Correll	24 July 2008	M	LJB242 LJB192	OAX OAX LJB242 ECOSUR-TAP 000304

Most of the herbarium specimens and some of the specimens in the living collection were collected by Laura Jiménez Bautista (LJB), a student of the project.

One specimen has been placed into the MEXU! Herbarium, as a possible new species.

000065–000404: Folio numbers of the Herbarium ECOSUR-TAP (ECOSUR- TAP), including LBJ project collection numbers.

* Accession numbers of the Orchidarium "Santo Domingo," (collection in-vivo and included in the data base of the project "Ecology and Sustainable Cultivation of Native Soconuscan Orchids), prefixed by JBSOC-ECOSUR-TAP-MEX.

OAX OAX, with Project collection number: Specimens collected by LBJ and deposited in the Herbarium of the "Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional Unidad Oaxaca," Instituto Politécnico Nacional.

A single hard pollinium may contain more than a million pollen grains, yet pollen:ovule ratios in Orchidaceae are far lower than plants with independent pollen grains because of the lack of wastage (Johnson & Edwards 2000). It is interesting to compare the ways that different plant groups economize and at the same time maximize their chances of reproduction. Orchids in general, have low wastage of pollen, potentially require only a single visit by a pollinating agent to donate the entire pollen load, often have very low percentage pollination, benefit from the fact that a single

successful pollination event translates into the production of thousands or millions of seeds, but suffer from recruitment limitation because few seeds develop into plants due to difficulties in finding a suitable substrate combined with a suitable fungal symbiont. Orchids, therefore, maximize the number of seeds produced per successful pollination event (Pérez-Hernández et al. 2011), and thus maximize efficiency in a different way to other Angiosperms, for which there is heavy wastage of pollen grains (up to 99%: Johnson and Edwards 2000), multiple visits are required to transport the entire pollen load of a flower, but there is usually higher percentage pollination, and greater possibilities that seeds will go on to produce young plants.

The rarity and low frequency of many species of orchids may be reflected in the extended viability of the pollen, giving time for pollinators to come into contact with another flower of the same species. Surprisingly, however, available data suggest that pollinaria are usually deposited within a few meters of the parent plant, but most work has been done on populations of terrestrial orchids which may have different tendencies to epiphytic species. Orchid pollinaria can stick to and function best on smooth surfaces, whereas loose (''dusty,'' ''floury'') pollen is most effective with hair or feathers (Johnson & Edwards 2000). In this way orchids may avoid competition and be able to exploit mobile organisms that do not pollinate other plants. At the same time, the efficiency of pollination may be negatively affected by the logistics of pollinaria transport, where heavy, dangling, or multiple pollinaria loads may interfere with flight and foraging activities, depending upon when and where on the body they are placed and how long they remain there. The various mechanisms by which orchids avoid the deposition of pollinaria on the stigmas of flowers from the same plant (geitonogamy) are perhaps the most fascinating aspect of orchid sexual reproduction (Johnson & Edwards 2000).

The number of pollinia per pollinarium, the size and form of the pollinarium and accessory structures and are all important diagnostic tools. Furthermore, the position of the pollinarium on the pollinator's body can be indicative of certain floral attributes and aid in identification (Singer 2008). The way in which individual pollen grains are nested together within the pollinia can also be a useful diagnostic tool (Nieto & Damon 2008).

The region of Soconusco (latitude 16°N, longitude 92°W), in southeast Mexico, on the border with Guatemala has a variety of ecosystems and climates but has undergone severe environmental degradation in recent years. The region includes the Biological Corridor Tacaná-Boquerón, within the Sierra Madre Mountains, now known to be the

TABLE 2A. Morphological and morphometric characteristics of the pollinia and tetrads of the orchid species of Subtribe Spiranthinae (Subfamily Orchidoideae).

Orchid species	No. pollinia	Size of pollinia (mm)		L/W ratio	Shape of Pollinia	Caudicles or stipe	Texture	Size of Tetrad (μ)	Shape of tetrad	Surface tetrads	Surface exine layer	Interior exine layer
		length	width					length × width				
Cyclopogon sp.	4	1.61	0.38	4.23	narrowly ellipsoidal	n.p.[e]	powdery	38.5 × 25.1	tetragonal, rhomboidal, linear	slightly elongate	foveolate	foveolate
Dichromanthus aurantiacus[R]	4	9.80	0.78	12.56	almost cylindrical	n.p.[e]	powdery	49.2 × 31.2	rhomboidal, tetragonal, linear, T-shaped	elongate	reticulate	reticulate
Pelexia funkiana	4	4.07	0.66	6.17	cuneiform	n.p.[e]	powdery	46.5 × 31.0	rhomboidal	isometric	reticulate	reticulate
Stenorrhynchos speciosum	4	6.03	0.54	11.17	almost cylindrical	n.p.[e]	powdery	47.1 × 27.8	rhomboidal	slightly elongate	reticulate	reticulate
Schiedeella jeanmulleri Szlach., Rutk. & Mytnik	4	1.30	0.44	2.95	narrowly ellipsoidal	n.p.[e]	powdery	34.1 × 29.7	tetragonal, rhomboidal, tetrahedral	slightly elongate	reticulate	reticulate

[R] average of two repetitions.
[e] not present.

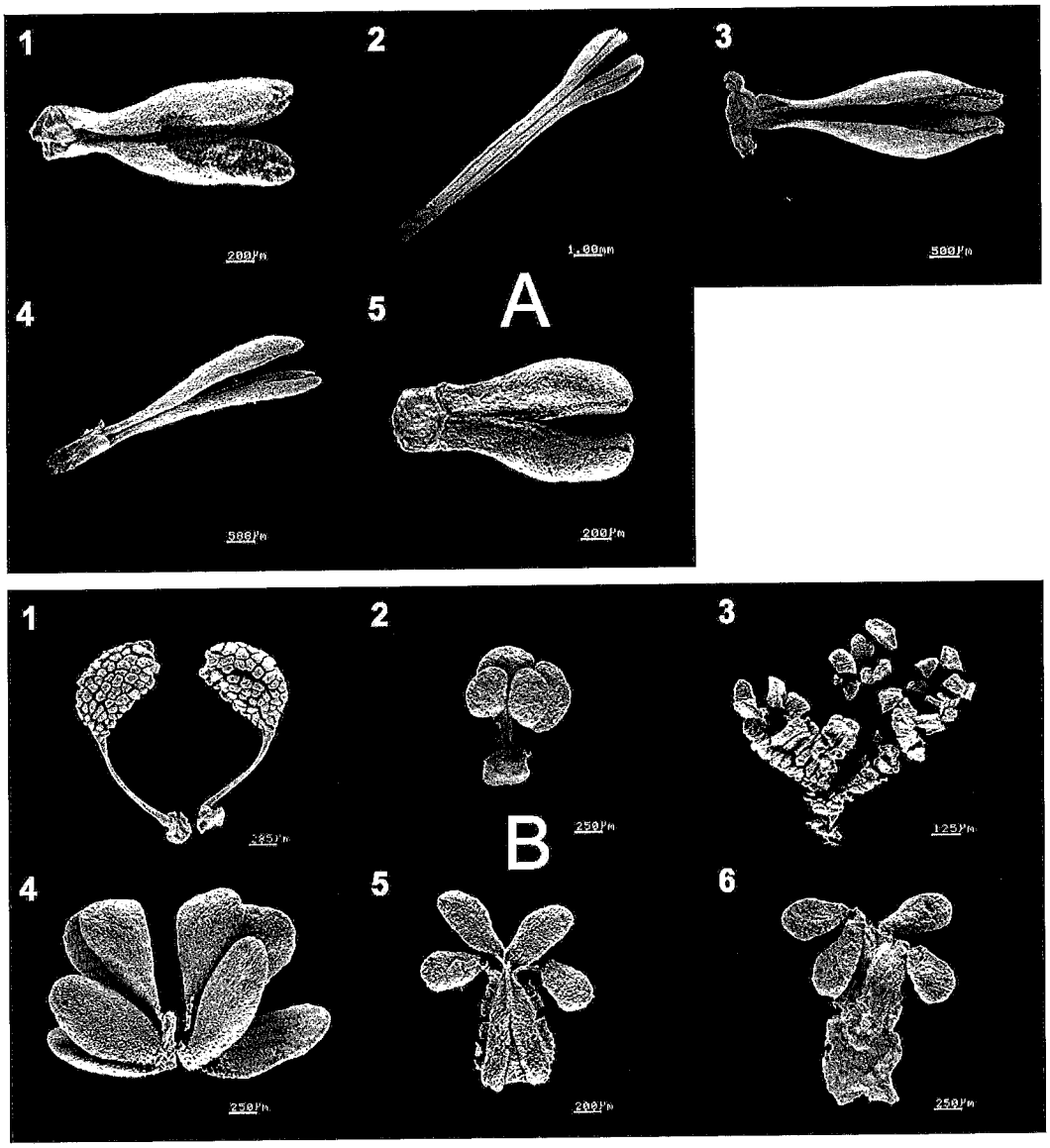

FIGURE 1a:A. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Spiranthinae (Subfamily Orchidoideae): Photographs of images taken by a scanning electron microscope of fresh, entire, unprocessed pollinia. Images taken under conditions of low vacuum at 25–30 kV. 1) *Cyclopogon* sp., 2) *Dichromanthus aurantiacus,* 3) *Pelexia funkiana,* 4) *Stenorrhynchos speciosum,* 5) *Schiedeella jean-mulleri.*

FIGURE 1a:B. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribes Calypsoeae, Goodyerinae, Orchidinae (Subfamily Orchidoideae), Subtribes Bletiinae and Ponerinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of fresh, entire, unprocessed pollinia. Images taken under conditions of low vacuum at 25–30 kV. 1) *Habenaria odontopetala,* 2) *Govenia mutica,* 3) *Goodyera striata,* 4) *Bletia purpurea,* 5) *Isochilus aurantiacus,* 6) *Isochilus chiriquensis.*

second most orchid species rich region in Mexico (Damon & Solano, unpubl. data).

The project "Ecology and Sustainable Cultivation of Native Orchids in Soconusco" is dedicated to the search for mechanisms for the conservation and sustainable exploitation of native orchids and research work covers various aspects of orchid ecology, including pollination, beneficial interactions with fungi and bacteria, sustainable cultivation and the biological control of orchid pests.

The present study of the morphology of the pollinaria of 56 species of orchids growing within

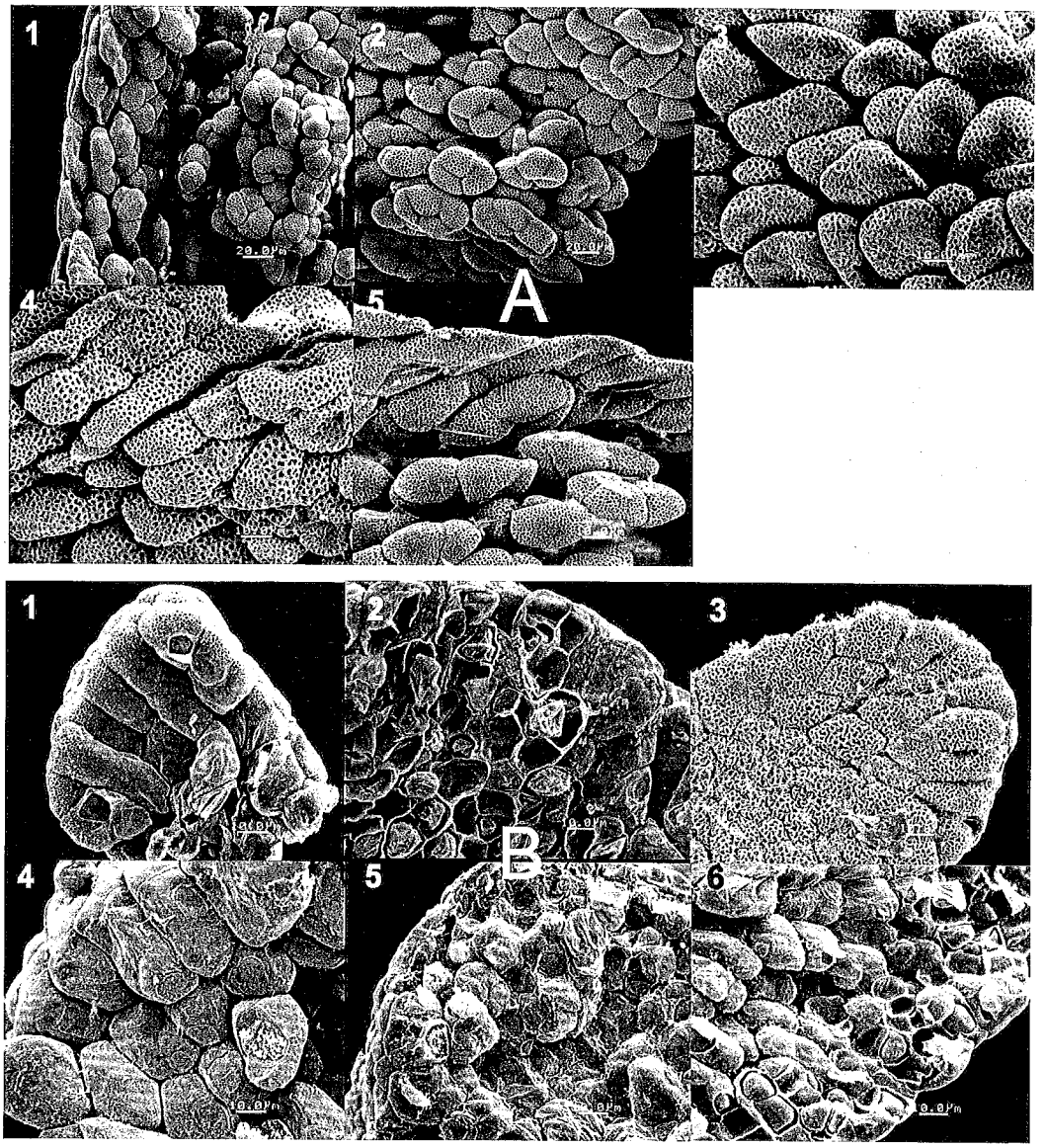

FIGURE 2a:A. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Spiranthinae (Subfamily Orchidoideae): Photographs of images taken by a scanning electron microscope of the tetrads towards the interior of the pollinia, after processing and dry-fracture. Images augmented ×1000 and taken under conditions of high vacuum at 10–15 kV. 1) *Cyclopogon* sp., 2) *Dichromanthus aurantiacus,* 3) *Pelexia funkiana,* 4) *Stenorrhynchos speciosum,* 5) *Schiedeella jean-mulleri.*

FIGURE 2a:B. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribes Calypsoeae, Goodyerinae, Orchidinae (Subfamily Orchidoideae), Subtribes Bletiinae and Ponerinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of the tetrads towards the interior of the pollinia, after processing and dry-fracture. Images augmented ×1000 and taken under conditions of high vacuum at 10–15 kV. 1) *Habenaria odontopetala,* 2) *Govenia mutica,* 3) *Goodyera striata,* 4) *Bletia purpurea,* 5) *Isochilus aurantiacus,* 6) *Isochilus chiriquensis.*

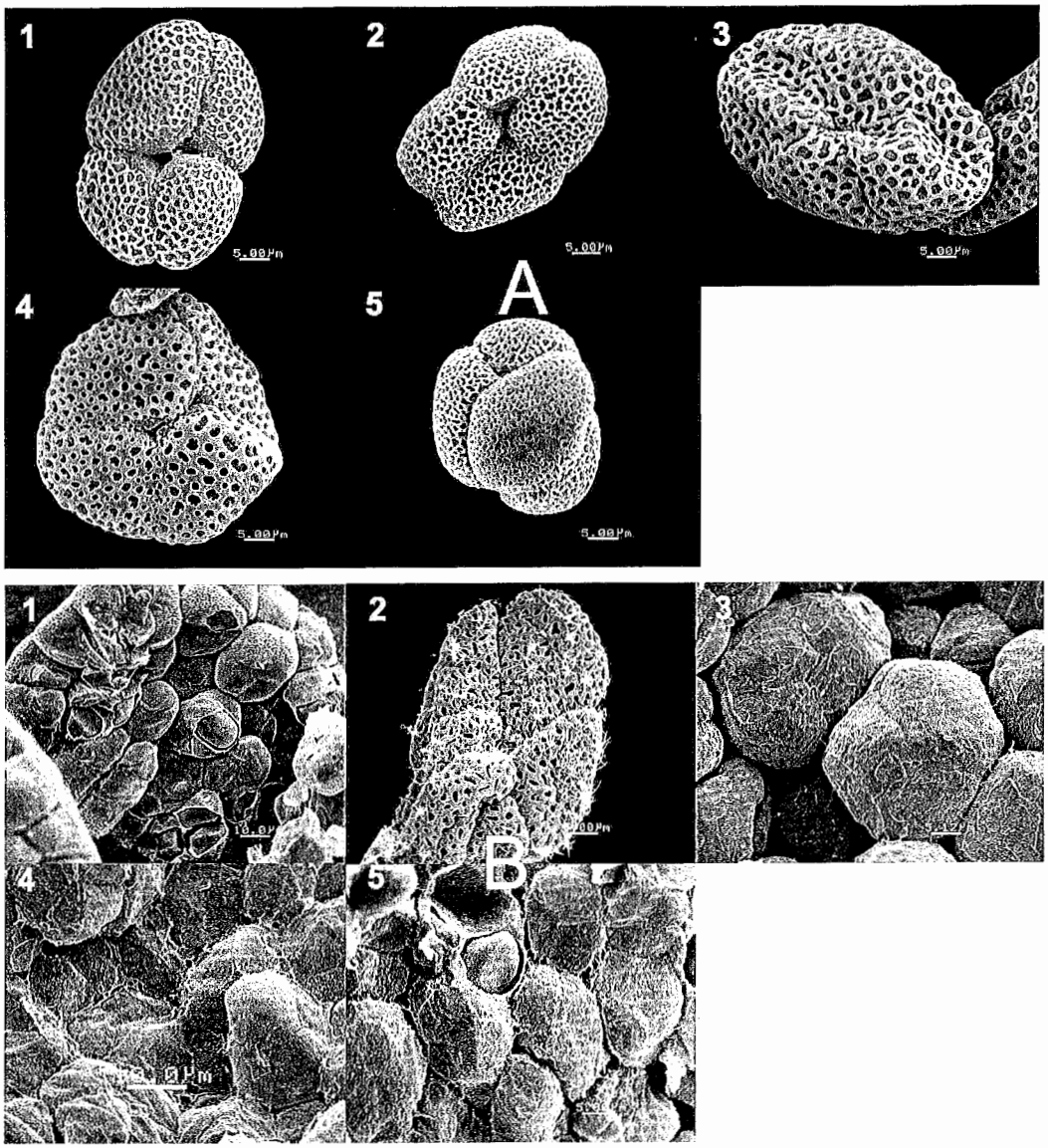

FIGURE 3a:A. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Spiranthinae (Subfamily Orchidoideae): Photographs of images taken by a scanning electron microscope of the tetrads towards the interior of the pollinia, after processing and dry-fracture. Images augmented ×2000 and taken under conditions of high vacuum at 10–15 kV. 1) *Cyclopogon* sp., 2) *Dichromanthus aurantiacus,* 3) *Pelexia funkiana,* 4) *Stenorrhynchos speciosum,* 5) *Schiedeella jean-mulleri.*

FIGURE 3a:B. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribes Calypsoeae, Goodyerinae, Orchidinae (Subfamily Orchidoideae), Subtribes Bletiinae and Ponerinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of the tetrads towards the interior of the pollinia, after processing and dry-fracture. Images augmented ×2000 and taken under conditions of high vacuum at 10–15 kV. 1) *Habenaria odontopetala,* 2) *Goodyera striata,* 3) *Bletia purpurea,* 4) *Isochilus aurantiacus,* 5) *Isochilus chiriquensis.*

the Biological Corridor Tacaná-Boqueron, in the region of Soconusco in southeastern Mexico is a sequel to the 92 orchid species covered in Nieto and Damon (2008). We contribute further to the morphological analysis of the pollinaria of Soconuscan orchids to enable us to identify the pollinaria, pollinia, stipes and caudicles carried on the bodies of pollinating insects and birds captured during observations and controlled experiments on pollination in the region.

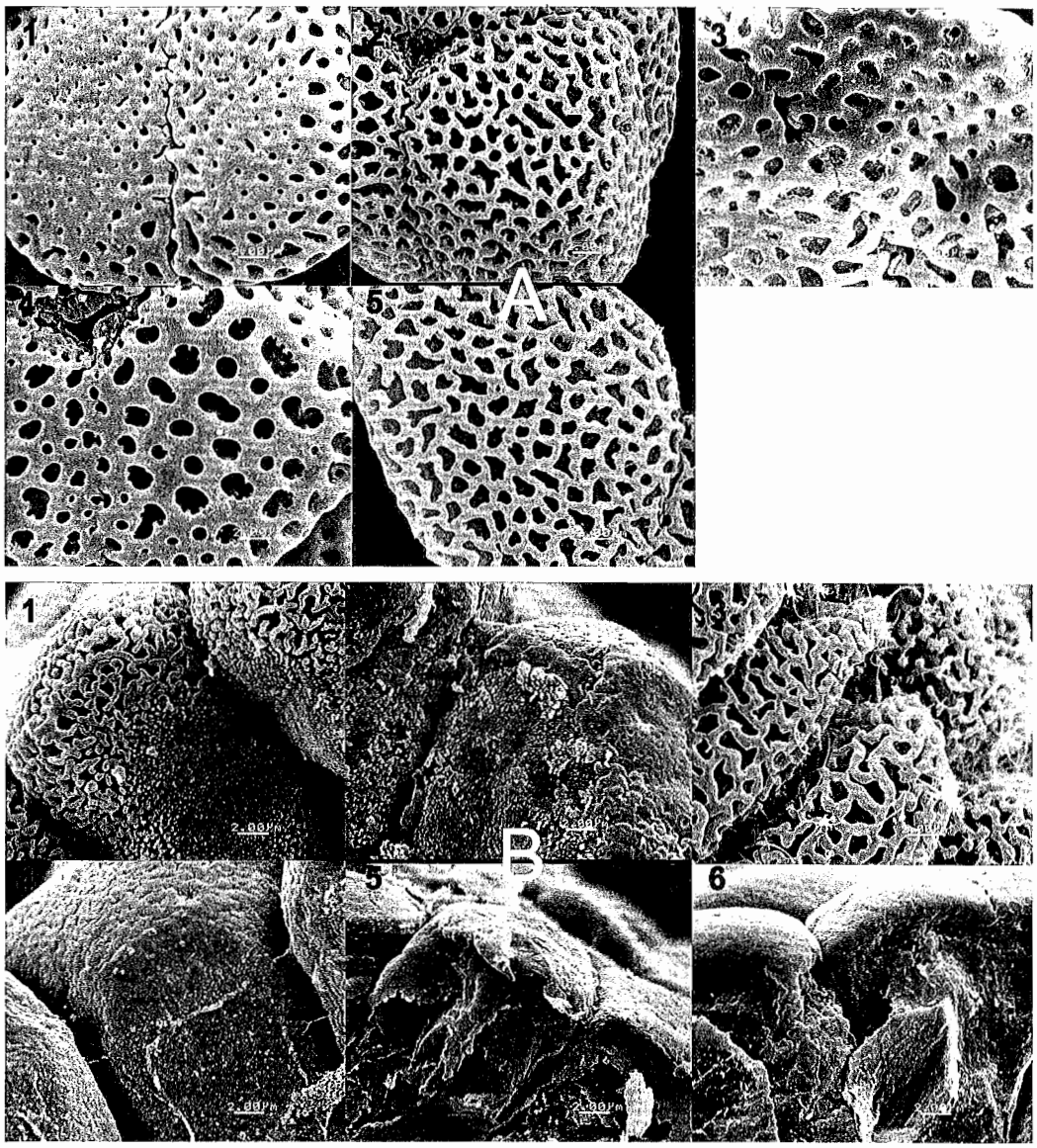

FIGURE 4a:A. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Spiranthinae (Subfamily Orchidoideae): Photographs of images taken by a scanning electron microscope of the exine layer of the interior and exterior walls of the surface tetrads of pollinia. Images augmented ×5000 and taken under conditions of high vacuum at 10–15 kV. 1) *Cyclopogon* sp., 2) *Dichromanthus aurantiacus,* 3) *Pelexia funkiana,* 4) *Stenorrhynchos speciosum,* 5) *Schiedeella jean-mulleri.*

FIGURE 4a:B. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribes Calypsoeae, Goodyerinae, Orchidinae (Subfamily Orchidoideae), Subtribes Bletiinae and Ponerinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of the exine layer of the interior and exterior walls of the surface tetrads of pollinia. Images augmented ×5000 and taken under conditions of high vacuum at 10–15 kV. 1) *Habenaria odontopetala,* 2) *Govenia mutica,* 3) *Goodyera striata,* 4) *Bletia purpurea,* 5) *Isochilus aurantiacus,* 6) *Isochilus chiriquensis.*

TABLE 2B. Morphological and morphometric characteristics of the pollinia and tetrads of the orchid species of Subtribes Orchidinae Calypsoeae, Goodyerinae (Subfamily Orchidoideae) and Subtribes Bletinae and Ponerinae (Subfamily Epidendroideae).

Orchid species	No. pollinia	Size of pollinia (mm) length	width	L/W ratio	Shape of pollinia	Caudicles
Subtribe Orchidinae						
Habenaria odontopetala	2	0.91	0.58	1.57	ellipsoidal	hyaline, very long
Subtribe Calypsoeae						
Govenia mutica	2 l[a] 2 s[b]	0.68 0.53	0.48 0.42	1.42 1.26	broadly ellipsoidal	granular, long, 4 fused caudicles
Subtribe Goodyerinae						
Goodyera striata	2	0.64	0.23	2.78	clavate	granular very short, simple
Subribe Bletinae						
Bletia purpurea	8	1.17	0.67	1.75	ellipsoidal, flattened and obovoid flattened	hyaline, granular, ventral mass
Subtribe Ponerinae						
Isochilus aurantiacus	2 l[a] 2 s[b]	0.60 0.47	0.28 0.28	2.14 1.68	ellipsoidal, flattened	hyaline, granular, long, 4 fused caudicles
Isochilus chiriquensis	4	0.62	0.34	1.82	ellipsoidal, flattened	hyaline, granular, long, 4 fused caudicles

[R] average of two repetitions.
[a] large.
[b] small.
[c] not determined.
[d] c. compact.

MATERIALS AND METHODS

All of the biological material, consisting of fresh flowers from 56 species of orchids, (TABLE 1) was collected from the field (fragments of cloud forest, pine-oak forest and cultivated areas). Under these conditions it was not possible to estimate the age of the flower and it is possible that some pollinaria were older and more dehydrated at the time of collection. Living samples of these higher altitude species are maintained in the annex to the Regional Botanical Garden "El Soconusco," the Orchidarium "Santo Domingo," in the municipality of Unión Juárez, Chiapas (Altitude 1200 m. 15°03′45″N; 92°04′50″W). Herbarium specimens were deposited in the Herbarium of ECOSUR-Tapachula and in the Herbarium of the collaborating institution, "Centro Interdisciplinario de Investigacion para el Desarrollo Integral Regional" (CIIDIR), Oaxaca, Instituto Politecnico Nacional (IPN)."

A total of 56 species from 30 genera were included in this study, of which 54 were fully determined and two were identified to genus and may both be new species (TABLE 1). For a few of the species a second sample was obtained during the study period and a repetition was carried out (*).

Flowers were placed into inflated, sealed plastic bags with details of plant species, date and locality, and transported to the laboratory in ECOSUR in Tapachula. The date on which the flower was collected, i.e., the flowering date, is recorded.

The methods used for the morphological analysis of the pollinaria were the same as for Nieto and Damon (2008). Observations were carried out under conditions of low vacuum using a SEM Topcon SM 510. Although the scanning electron microscope (SEM) is not the traditional method for the study of pollen morphology, it offers particularly valuable details of forms and patterns that cannot be visualized by either the transmission electron microscope (TEM), or the optical microscope (OM) (Moore et al., 1991). An evaluation of the methodology used is also included in Nieto & Damon (2008).

TABLE 2B. Extended.

Texture[d]	Size of Tetrad (μ) length × width	Shape of Tetrad	Surface tetrads	Surface exine layer	Interior exine layer
c. hard 1	27.1 × 20.9	linear, rhomboidal	elongate and isometric	reticulate, cristate	reticulate, cristate
c. hard 2	n.d.[c]	n.d.[c]	slightly elongate	scabrate to laevigate	scabrate
polyad c. hard 1 of 0.10 a 0.15 × 0.70 a 0.90	25.6 × 13.9	monads	monads slightly elongated	heterobrochate	heterobrochate
c. soft	31.6 × 22.6	calymmate	slightly elongate	microfossulate	granular
c. hard 1	21.6 × 16.8	calymmate	isometric	laevigate	laevigate
c. hard 1	21.5 × 14.5	calymmate	slightly elongate	laevigate to scabrate	laevigate to scabrate

RESULTS

The results of the measurements and the morphological characterization of the pollinia of the 56 species studied are presented in taxonomic order, in five groups to facilitate presentation and comparison of the data and images. (^{R}) Indicates that two specimens were analyzed, either from different plants or from the same plant, and may have been in different years.

The data for each column were as follows:

Number of pollinia (per pollinarium). Where the pollen masses presented different sizes, this is indicated by "l" for large and "s" for small.

Size of pollinia. Measured in millimeters, representing the total length and width of the pollinarium. Measurements were taken from the SEM images of both fresh and processed pollinaria. The number of measurements made depended upon the number of individual pollinium per pollinarium (2, 4, 6, 8), and an average was taken for each state. The size (width × length) reported is an average of the values of both states. This result is obviously an approximation and was further influenced by the orientation of the image of the sample from which the measurements were taken.

Length and width ratio. Derived from the average dimensions of the pollinia, this parameter was included in this second study as a further diagnostic tool.

Shape of pollinia. The shape of each pollinium was noted, using the terminology for symmetrical figures (SACDT 1962, and Stearn 1966). Additional notes are made if there is asymmetry on one side or face of the pollinia and if the form is irregular.

Stipe or caudicle. For groups that have stipes the size of the structure was measured; averages of the length and the widest part of the stipe are presented in millimeters. Where the group has caudicles, the texture and presentation of the structure are described; empty spaces in the table indicate that the pollinia do not have these accessory structures.

Texture. This is an appreciation of the image of the pollinia at 1000×, taken after a transverse cut was made. The following descriptions were applied: *Floury*, for a low level of compaction with both the exterior and the interior tetrads having an exine layer; *C. Soft 1* (compact soft, type 1), for pollinia that disintegrate easily when fractured and the tetrads and their arrangement are easy to see; *C. Soft 2* (compact soft, type 2), for pollinia that disintegrate easily when fractured but it is difficult to determine the arrangement of the tetrads. In this case, the four pollen grains share a common exine covering; *C. Hard 1* (compact hard texture, type 1), for pollinia that maintain entire tetrads when fractured, and in only a few cases was it possible to determine the arrangement of the

TABLE 3. Morphological and morphometric characteristics of the pollinia and tetrads of the orchid species of Subtribe Laelinae (Subfamily Epidendroideae).

Orchid species	No. pollinia	Size of pollinia (mm) length	Size of pollinia (mm) width	L/W ratio	Shape of pollinia
Arpophyllum medium	8	0.63	0.29	2.15	clavate
Barkeria spectabilis	4	1.41	0.97	1.45	obovoid, flattened, with one straight side
Chysis bractescens	4 l[a] 4 s[b]	1.67 1.29	1.11 0.78	1.29 1.16	broadly ellipsoidal, flattened
Epidendrum cnemidophorum	2 l[a] 2 s[b]	1.16 1.09	1.15 1.03	1.00 1.06	lingulate
Epidendrum culmiforme	4	0.51	0.43	1.19	broadly obovoid, flattened
Epidendrum dixorum	4	0.66	0.54	1.22	broadly obovoid, flattened
Epidendrum eximium	4	0.92	0.60	1.53	obovoid, flattened, with one straight side
Epidendrum parkinsonianum[R]	4	1.62	1.46	1.11	lingulate
Epidendrum radicans	4	0.84	0.47	1.79	ellipsoidal, flattened
Epidendrum sobralioides	4	0.87	0.73	1.19	broadly obovoid, flattened with one straight side
Prosthechea brassavolae	4	1.23	0.42	2.93	narrowly ellipsoidal, flattened
Prosthechea varicosa	4	0.72	0.50	1.44	obovoid flattened, with one straight side
Prosthechea vitelina[R]	4	1.05	0.81	1.29	broadly obovoid, flattened

[R] average of two repetitions.
[a] large.
[b] small.
[c] not determined.
[d] c. compact.

pollen grains within the tetrads; *C. Hard 2* (compact hard texture, type 2), for pollinia that do not fracture easily and the walls of the pollen grains almost always break. In some cases, a thicker wall joining the individual pollen grains was observed and it was not possible to determine the arrangement of the tetrads in this category.

Size of tetrad. Where possible, measurements of the length and width of the tetrads were taken from images at 2000× and are presented in microns. The size reported is the average of the measurements made of 10 to 15 interior tetrads from the same pollinium.

Shape of tetrad. The arrangement of the pollen grains towards the interior of the tetrads is described. Where two different arrangements are presented for the same species, the first mentioned is the most frequent. The term *calymmate* refers to those tetrads in which the pollen grains share a common covering of exine. It was not possible to determine the arrangement of pollinia with *C. Hard 2* texture, and images of the tetrads for these species are not included.

Surface tetrads. The tetrads on the surface of the pollinia are described as isometric when they have the same arrangement as the tetrads towards the interior of the pollinia, with no elongation. "Slightly elongated" refers to surface tetrads that are linear and slightly stretched in comparison with interior tetrads. "Elongated tetrads" are approximately twice as long as wide. These arrangements can be observed 1000× when the pollinia are fractured and include an edge and part of the interior.

Superficial exine layer. The main ornamentation of the exine layer of the external walls of the surface tetrads is described. This parameter can be appreciated at 5000×.

Interior exine layer. The ornamentation of the exine layer of the internal walls of the surface tetrads is described. This parameter can be appreciated at 5000×.

TABLE 3. Extended.

Caudicles	Texture[d]	Size of tetrad (μ) length × width	Shape of tetrad	Surface tetrads	Surface exine layer	Interior exine layer
hyaline ventral mass	c. soft	21.4 × 19.8	calymmate	isometric	scabrate	scabrate
granular, long, simple	c. hard 1	23.0 × 15.2	rhomboidal, tetrahedral	elongate	laevigate	scabrate
single ventral granular, wide	c. hard 1	25.2 × 13.5	calymmate	elongate	scabrate to laevigate	scabrate to laevigate
granular, long, 2 fused caudicles	c. hard 2	n.d.[c]	n.d.[c]	slightly elongate	scabrate to laevigate	scabrate
granular, hyaline, long, 2 fused caudicles	c. hard 2	n.d.[c]	n.d.[c]	slightly elongate	laevigate	scabrate
granular, hyaline, long, 2 fused caudicles	c. hard 2	n.d.[c]	n.d.[c]	slightly elongate	laevigate	gemmate
granular, hyaline, long, 2 fused caudicles	c. hard 2	n.d.[c]	n.d.[c]	slightly elongate	scabrate to laevigate	scabrate
granular, long, 2 fused caudicles	c. hard 1	21.9 × 14.6	calymmate	elongate	laevigate	scabrate
granular, long, 2 fused caudicles	c. soft	23.5 × 21.9	rhomboidal	slightly elongate	laevigate	scabrate
granular, hyaline, long, 2 fused caudicles	c. hard 1	23.1 × 15.2	calymmate	slightly elongate	scabrate to laevigate	scabrate
granular, long, simple	c. soft	15.6 × 11.6	calymmate	isometric	laevigate	scabrate
granular, long, simple	c. hard 1	12.7 × 13.4	calymmate	isometric	scabrate to laevigate	scabrate
granular, long, simple	c. soft	24.9 × 18.8	tetrahedral	slightly elongate	laevigate	scabrate

Collection Sites

AC: Ejido Agua Caliente, Municipality of Motozintla, Chiapas.
BB: Ejido Boquerón Buenavista, Municipality of Motozintla, Chiapas.
BB-EN El Naranjo, Ejido Boquerón Buena vista, Municipality of Motozintla, Chiapas.
BJ: Ejido Benito Juárez el Plan, Municipality of Cacahoatán, Chiapas.
BB-PEN Pines in the Clouds, Ejido Boquerón Buenavista, Municipality of Moto zintla, Chiapas.
BER. Ejido Berriozabal, Municipality of Cacahoatán, Chiapas.
BV: Ejido Buena Vista, Municipality of Motozintla, Chiapas.
BB-V Los Volveres, Ejido Boquerón Buenavista, Municipality of Motozintla, Chiapas.
FLJ: Finca La Joya, Municipality of Tapachula, Chiapas.
FM: Ejido Fracción Montecristo, Municipality of Cacahoatán, Chiapas.
LP: Ejido La Patria, Municipality of Tapachula, Chiapas.
M: Ejido Milán, Municipality of Cacahoatán, Chiapas.
MOT Motozintla, Municipality of Motozintla, Chiapas.
P Palenque, Municipality of Palenque, Chiapas.
PEL Ejido Peloponeso, Municipality of Tapachula, Chiapas.
SR: Ejido Santa Rosalía, Municipality of Tapachula, Chiapas.

Various specimens were collected and then maintained in the Orchidarium "Santo Domingo," where they flowered the following years and the pollinaria were collected at that later date for analysis. In other cases the pollinaria were extracted directly from newly collected plants.

Voucher Specimens

All of the pollinaria were taken from plants collected from natural habitats in the places indicated in TABLE 1. All plants are referenced in the data base of the project "Ecology and Sustainable Cultivation of Native Soconuscan Orchids," and most are maintained in the living collection of the annex of the Regional Botanical Garden "El Soconusco," Orchidarium "Santo Domingo," in the Municipality of Unión Juárez, in the state of Chiapas. The accession numbers are included in TABLE 1 for reference. Due to the

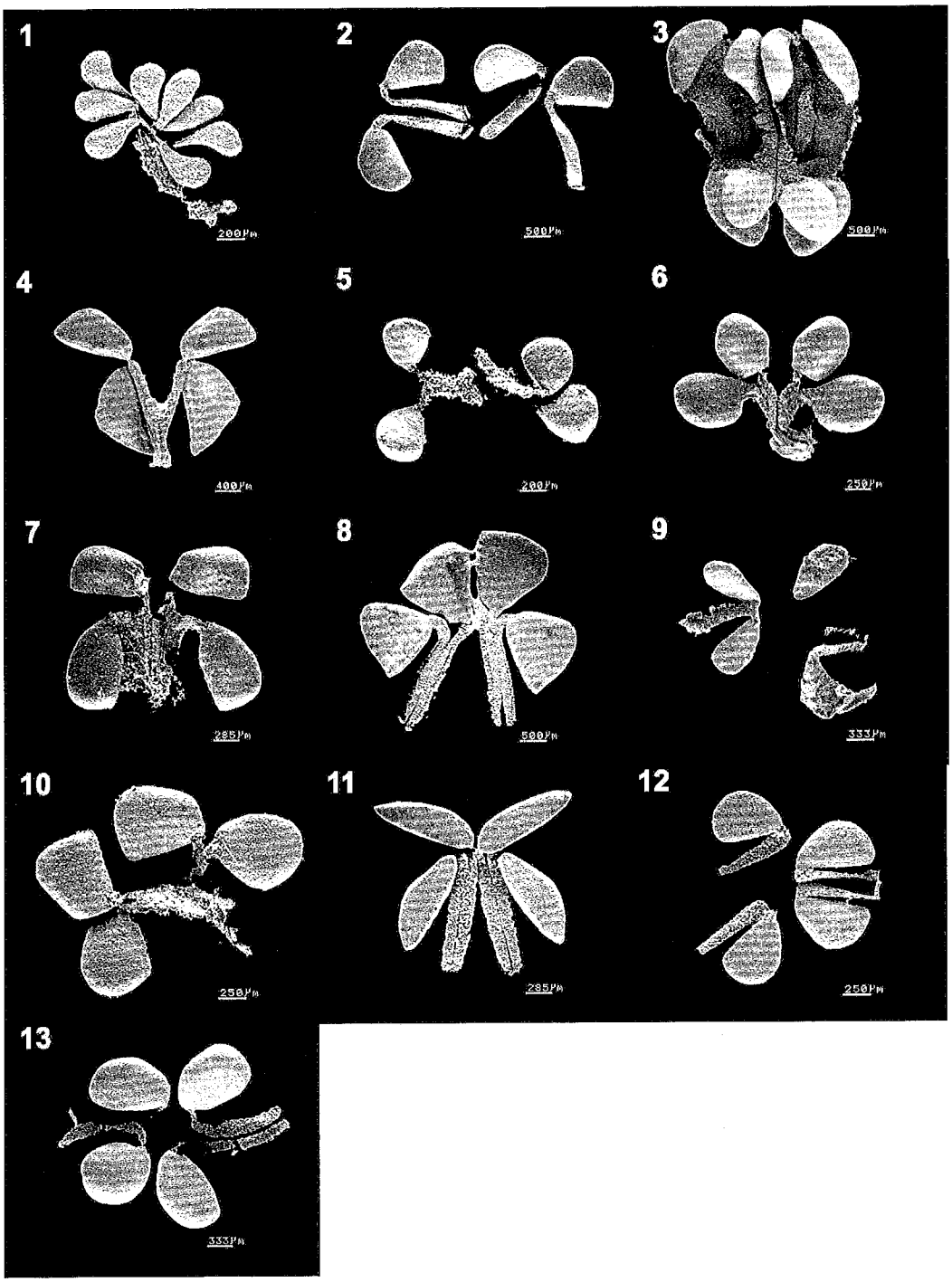

FIGURE 1b. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Laelinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of fresh, entire, unprocessed pollinia. Images taken under conditions of low vacuum at 25–30 kV. 1) *Arpophyllum medium,* 2) *Barkeria spectabilis,* 3) *Chysis bractescens,* 4) *Epidendrum cnemidophorum,* 5) *Epidendrum culmiforme,* 6) *Epidendrum dixorum;* 7) *Epidendrum eximium,* 8) *Epidendrum parkinsonianum,* 9) *Epidendrum radicans,* 10) *Epidendrum sobralioides,* 11) *Prosthechea brassavolae,* 12) *Prosthechea varicosa,* 13) *Prosthechea vitelina.*

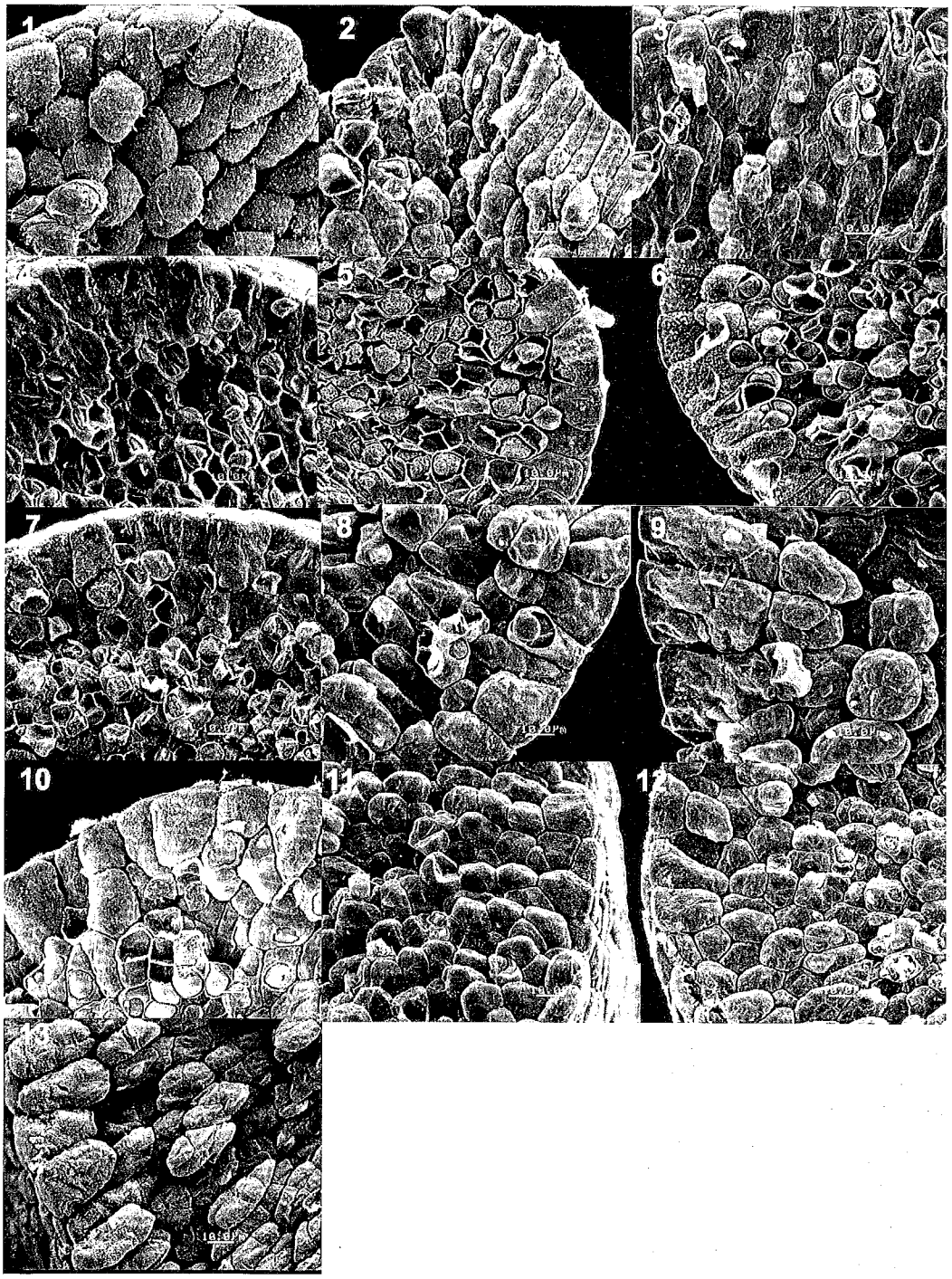

FIGURE 2b. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Laelinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of the tetrads towards the interior of the pollinia, after processing and dry-fracture. Images augmented ×1000 and taken under conditions of high vacuum at 10–15 kV. 1) *Arpophyllum medium,* 2) *Barkeria spectabilis,* 3) *Chysis bractescens,* 4) *Epidendrum cnemidophorum,* 5) *Epidendrum culmiforme,* 6) *Epidendrum dixorum,* 7) *Epidendrum eximium,* 8) *Epidendrum parkinsonianum,* 9) *Epidendrum radicans,* 10) *Epidendrum sobralioides,* 11) *Prosthechea brassavolae,* 12) *Prosthechea varicosa,* 13) *Prosthechea vitelina.*

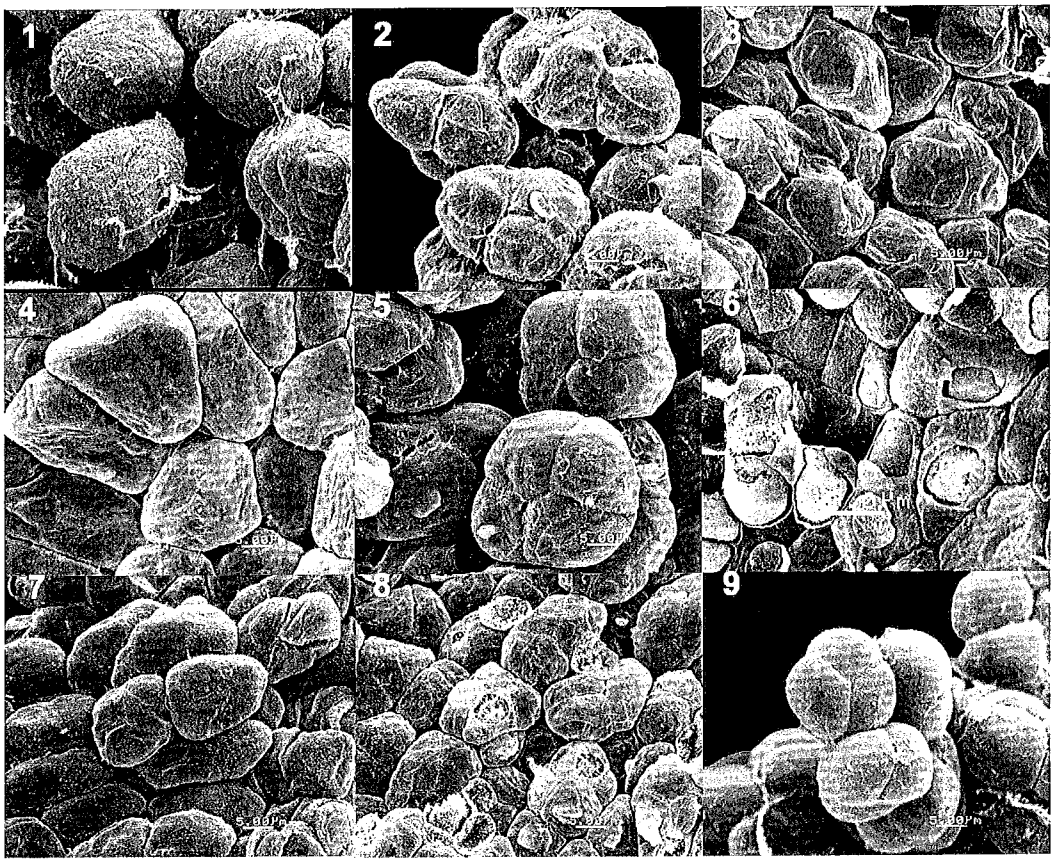

FIGURE 3b. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Laelinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of the tetrads towards the interior of the pollinia, after processing and dry-fracture. Images augmented ×2000 and taken under conditions of high vacuum at 10–15 kV. 1) *Arpophyllum medium,* 2) *Barkeria spectabilis,* 3) *Chysis bractescens,* 4) *Epidendrum parkinsonianum,* 5) *Epidendrum radicans,* 6) *Epidendrum sobralioides,* 7) *Prosthechea brassavolae,* 8) *Prosthechea varicosa,* 9) *Prosthechea vitelina.*

rarity of many of the species, only a few species (indicated in TABLE 1) are represented in the Herbarium of ECOSUR-Tapachula and the Herbarium of CIIDIR-IPN.

RESULTS AND DISCUSSION

The descriptions presented are brief, and reference to some of the 92 species mentioned in Damon and Nieto (2008) is made where basic characteristics coincide with, or differ notably from related species and genera included in the present study. However, to examine coincidences and differences in detail please refer to that first article. In this second study, the caudicles of *Pleurothallis*, *Specklinia* and *Stelis* are described, whereas this information was mostly omitted in the first study. Here we also include a parameter which was not considered in the first study, which is the length:width ratio of the pollinia as another useful, diagnostic tool for the determination of pollinia transported by pollinating organisms or for taxonomic purposes. A full analysis and comparison of all the species studied will be included in a third and final publication in 2013.

Subfamily Orchidoideae

1. *Tribe Cranichideae*

a. Subtribe Spiranthinae (*Cyclopogon, Dichromanthus, Pelexia, Stenorryhnchos, Schiedeella*)

The data for this group is presented in TABLE 2A, and FIGURES 1a:A, 2a:A, 3a:A, 4a:A.

The analysis was carried out with the help of Balogh (1982). The pollinaria of all the species of Subtribe Spiranthinae studied have four pollinia. The largest is the long, thin pollinarium of

FIGURE 4b. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Laelinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of the exine layer of the interior and exterior walls of the surface tetrads of pollinia. Images augmented ×5000 and taken under conditions of high vacuum at 10–15 kV. 1) *Arpophyllum medium,* 2) *Barkeria spectabilis,* 3) *Chysis bractescens,* 4) *Epidendrum cnemidophorum,* 5) *Epidendrum culmiforme,* 6) *Epidendrum dixorum;* 7) *Epidendrum eximium,* 8) *Epidendrum parkinsonianum,* 9) *Epidendrum radicans,* 10) *Epidendrum sobralioides,* 11) *Prosthechea brassavolae,* 12) *Prosthechea varicosa,* 13) *Prosthechea vitelina.*

TABLE 4. Morphological and morphometric characteristics of the pollinia and tetrads of the orchid species of Subtribe Pleurothallidinae (Subfamily Epidendroideae).

Orchid species	No. pollinia	Size of pollinia (mm) length	width	L/W ratio	Shape of pollinia
Anathalis dolichopus	2	0.37	0.34	1.09	deltoid
Lepanthes acuminata subsp. *acuminata*[R]	2	0.45	0.19	2.37	clavate
Masdevallia tuerckheimii[R]	2	0.56	0.30	1.87	obovoid, flattened
Pleurothallis leucantha[R]	2	0.38	0.21	1.81	obovoid, flattened
Pleurothallis matudana[R]	2	0.78	0.27	2.89	clavate
Pleurothallis nelsonii[R]	2	0.66	0.32	2.06	clavate
Pleurothallis pansamalae	2	0.43	0.21	2.05	obovoid, flattened
Pleurothallis saccatilabia	2	0.56	0.14	4.00	clavate
Specklinia fuegi	2	0.20	0.18	1.11	deltoid
Specklinia segregatifolia[R]	2	0.18	0.16	1.10	broadly obovoid, flattened
Stelis hymenantha	2	0.12	0.11	1.09	spheroid, flattened
Stelis megachlamys subsp. *megachlamys*	2	0.42	0.25	1.68	obovoid, flattened
Stelis tacanensis	2	0.28	0.22	1.27	deltoid
Stelis vespertina[R]	2	0.43	0.20	2.17	obovoid, flattened
Stelis villosa[R]	2	0.31	0.32	0.97	deltoid

[R] average of two repetitions.
[c] not determined.
[d] c. compact.
[e] not present.

Dichromanthus aurantiacus, with a length of 9.80 mm and width of 0.78 mm, which is similar in shape to the pollinaria of *Stenorrhynchos speciosum* which is also relatively large, with a length of 6.30 mm. Both these species have a higher length to width ratio. The smallest pollinium is that of *Schiedeella jean-mulleri*, measuring 1.30 × 0.44 mm, which also has the lowest length to width ratio. The four pollinia within the pollinaria of these species of Spiranthinae can be distinguished by thin lines along the entire length, which suggests that they are superposed. However, it is not possible to separate them without causing extensive damage, due to their fragile and floury consistency.

The pollinia of the five species studied are basically similar in form, and coincide with *Aulosepalum hemichreum* (as *Deirygyne hemichrea*) included in Nieto and Damon (2008). The pollinia may be described as narrowly ellipsoidal (*Cyclopogon* sp., cuneiform (*Pelexia funkiana*) or almost cylindrical (*Dichromanthus aurantiacus*, *Stenorrhynchos speciosum*). None of these species have caudicles or a stipe, instead, they have a viscidium as an accessory structure to facilitate adhesion to the pollinator. All species have pollinia with a powdery or floury texture, and the tetrads separate very easily. The tetrads of all the species studied are positioned in a basically rhomboid arrangement, with foveolate (*Cyclopogon* sp.) or reticulate (*D. aurantiacus*, *P. funkiana*, *S. speciosa* and *S. jean-mulleri*) surface and interior exine layers.

b. Subtribe Calypsoeae (*Govenia*)
c. Subtribe Goodyerinae (*Goodyera*)
d. Subtribe Orchidinae (*Habenaria*)

The data for this group is presented in TABLE 2B and FIGURES 1a:B, 2a:B, 3a:B, 4a:B.

Habenaria odontopetala of the subtribe Orchidinae has 2 very distinctively-shaped pollinia, with long, hyaline caudicles and reticulate-cristate surface and interior exine layers. *Govenia mutica* of the subtribe Calypsoeae has 4 pollinia presented as 2 small and 2 larger, both relatively small, measuring 0.68 × 0.48 and 0.53 × 0.42 mm, respectively. Each pollinia has a long, granular caudicle and the 4 are fused together. The surface and interior exine layers of the tetrads have a scabrate to laevigate and scabrate ornamentation, respectively. *Goodyera striata* of the subtribe Goodyerinae has 2 complex-shaped pollinia (FIGURE 1a-B: no. 3), with short, simple, granular caudicles. Both the surface and the

TABLE 4. Extended.

Caudicles	Texture[d]	Size of tetrad (μ) length × width	Shape of tetrad	Surface tetrads	Surface exine layer	Interior exine layer
granular, hyaline, very short	c. hard 2	n.d.[c]	n.d.[c]	isometric	fossulate	heterobrochate
granular, medium with hyaline mass	c. hard 2	n.d.[c]	n.d.[c]	isometric	microfoveolate	scabrate
n.p.[e], appears to be a stipe?	c. hard 2	n.d.[c]	n.d.[c]	isometric	scabrate to laevigate	scabrate
granular, short, with hyaline mass	c. hard 2	n.d.[c]	n.d.[c]	isometric	laevigate	laevigate
granular, short, with hyaline mass	c. hard 2	n.d.[c]	n.d.[c]	isometric	laevigate	laevigate
granular, medium	c. hard 2	n.d.[c]	n.d.[c]	isometric	laevigate	scabrate
granular, short, with hyaline mass	c. hard 2	n.d.[c]	n.d.[c]	isometric	laevigate	laevigate
granular, medium	c. hard 2	n.d.[c]	n.d.[c]	isometric	laevigate	laevigate
n.p.[e]	c. hard 2	n.d.[c]	n.d.[c]	isometric	laevigate	laevigate
granular, hyaline, very short	c. hard 2	n.d.[c]	n.d.[c]	isometric	scabrate	scabrate
granular, very short	c. hard 2	n.d.[c]	n.d.[c]	isometric	laevigate	heterobrochate
granular, very short	c. hard 2	n.d.[c]	n.d.[c]	isometric	laevigate	laevigate
granular hyaline, very short	c. hard 2	n.d.[c]	n.d.[c]	isometric	microfossulate	microfossulate
granular, short, with hyaline mass	c. hard 2	n.d.[c]	n.d.[c]	slightly elongate	laevigate	heterobrochate
granular hyaline, very short	c. hard 2	n.d.[c]	n.d.[c]	isometric	scabrate to laevigate	heterobrochate

interior exine layers hava a heterobrochate ornamentation. The textures of the pollinia of these species are all very different.

Subfamily Epidendroideae

1. Tribe Sobralieae

a. Subtribe Bletiinae (*Bletia*)

2. *Tribe Epidendreae*

a. Subtribe Ponerinae (*Isochilus*)

The data for this group is presented in TABLE 2B and FIGURES 1a:B, 2a:B, 3a:B, 4a:B.

Bletia purpura, of the Subtribe Bletiinae, has 8 pollinia, all with a similar size, and an average measurement of 1.17 × 0.67 mm. The shape of each pollinia is ellipsoidal flattened or obovoid flattened, the caudicle is present as a hyaline, granular mass, and the pollinia have a compact soft texture. The tetrads are calymmate with slightly elongate surface tetrads and a microfossulate surface exine layer and granulate interior exine layer.

Isochilus aurantiacus and *I. chiriquensis* of the Subtribe Ponerinae possess 4 ellipsoidal, flattened pollinia, slightly leveled off at the tip as seen for *I. carnosiflorus*, *I.* aff. *latibracteatus*, *I.* aff. *linearis*, *I.* aff. *major* and *Isochilus* sp. (Nieto & Damon 2008) and *I. aurantiacus* can be distinguished by having 2 small and 2 large pollinia which measure 0.47 × 0.28 and 0.68 × 0.28 mm, respectively. As for all the species of *Isochilus* studied, there are 4 fused, granular, hyaline caudicles. Both species have pollinia with a *C. Hard 1* texture and the shape of the tetrads is calymmate. The isometric surface tetrads of *I. aurantiacus* with laevigate surface and interior exine layers may be distinguished from the slightly elongate surface tetrads of *I. chiriquensis* with laevigate to scabrate exine layers.

b. Subtribe Laeliinae (*Arpophyllum*, *Barkeria*, *Chysis*, *Epidendrum*, *Prosthechea*)

The data for this group is presented in TABLE 3 and FIGURES 1b, 2b, 3b, 4b.

The subtribe Laeliinae is amply represented among the approximately 296 species of orchids currently registered for the Soconusco region (Damon & Solano, unpubl. data), and includes some of the most beautiful, overexploited and now endangered species (e.g., *Chysis bractescens*, *Barkeria spectabilis*), as well as some of the most common and resistant species that have adapted to human altered landscapes, such as *Epidendrum radicans* and *Prosthechea chacaoensis* (included in Nieto & Damon 2008) which is one of the most abundant species in the Soconusco region.

This sample of orchid species from the subtribe Laeliinae have similar characteristics to those included in Nieto & Damon (2008). Most of the species studied have 4 pollinia and two species

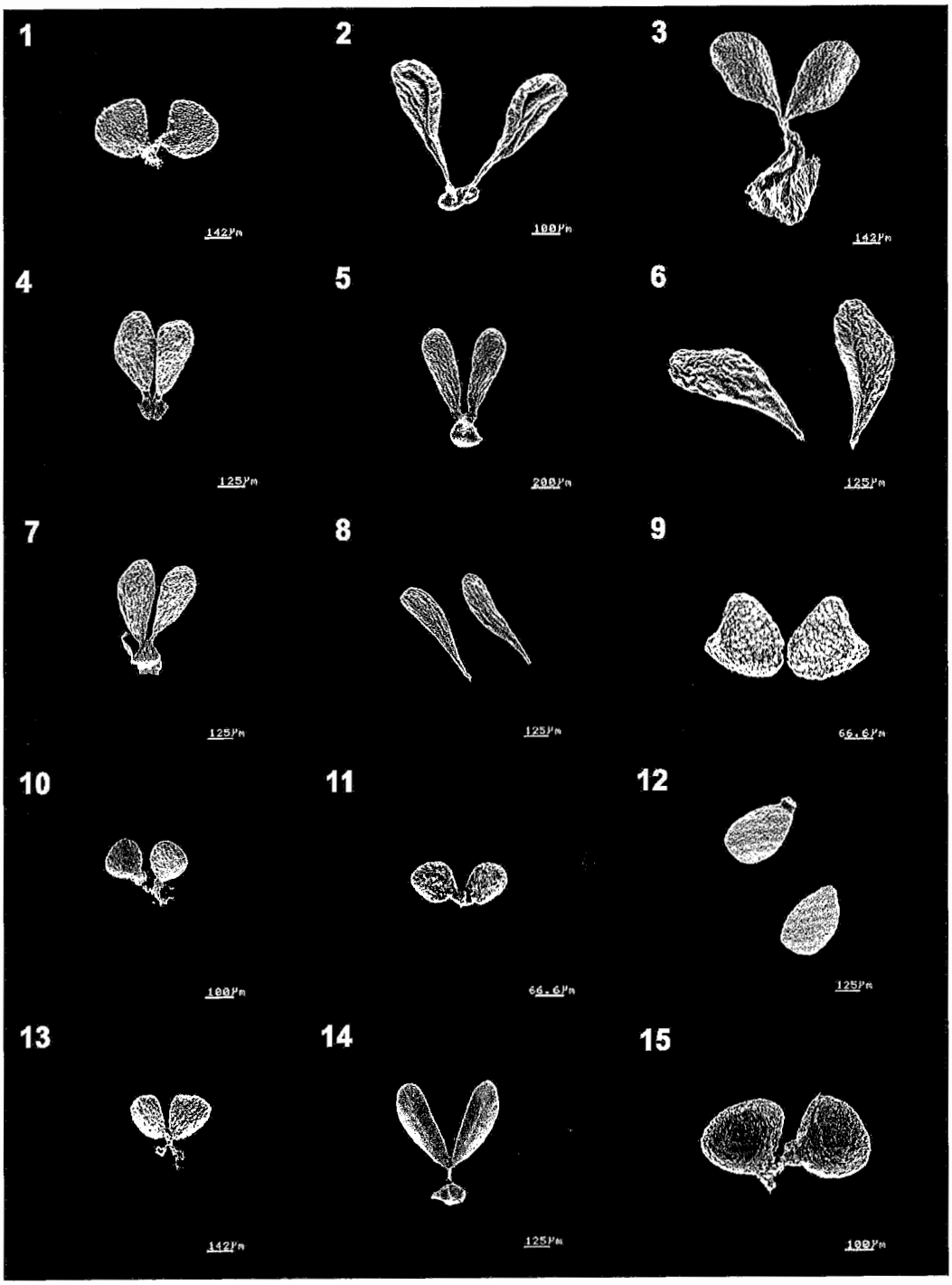

FIGURE 1c. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Pleurothallidinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of fresh, entire, unprocessed pollinia. Images taken under conditions of low vacuum at 25–30 kV. 1) *Anathallis dolichopus,* 2) *Lepanthes acuminata* subsp. *acuminata,* 3) *Masdevallia tuerckheimii,* 4) *Pleurothallis leucantha,* 5) *Pleurothallis matudana,* 6) *Pleurothallis nelsonii,* 7) *Pleurothallis pansamalae,* 8) *Pleurothallis saccatilabia,* 9) *Specklinia fuegi,* 10) *Specklinia segregatifolia,* 11) *Stelis hymenantha,* 12) *Stelis megachlamys* subsp. *megachlamys,* 13) *Stelis tacanensis,* 14) *Stelis vespertina,* 15) *Stelis villosa.*

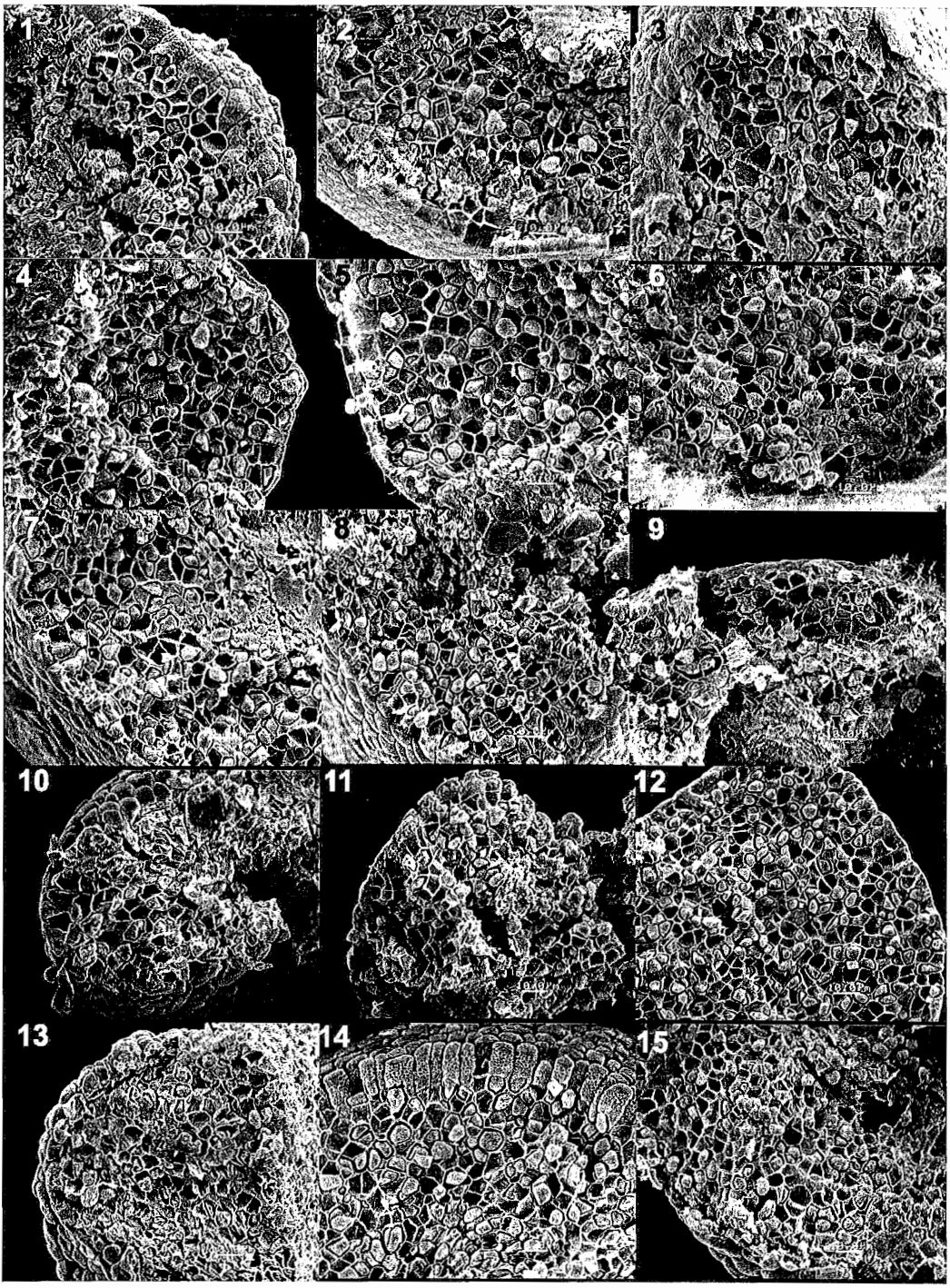

FIGURE 2c. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Pleurothallidinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of the tetrads towards the interior of the pollinia, after processing and dry-fracture. Images augmented ×1000 and taken under conditions of high vacuum at 10–15 kV. 1) *Anathallis dolichopus,* 2) *Lepanthes acuminata* subsp. *acuminata,* 3) *Masdevallia tuerckheimii,* 4) *Pleurothallis leucantha,* 5) *Pleurothallis matudana,* 6) *Pleurothallis nelsonii,* 7) *Pleurothallis pansamalae,* 8) *Pleurothallis saccatilabia,* 9) *Specklinia fuegi,* 10) *Specklinia segregatifolia,* 11) *Stelis hymenantha,* 12) *Stelis megachlamys* subsp. *megachlamys,* 13) *Stelis tacanensis,* 14) *Stelis vespertina,* 15) *Stelis villosa.*

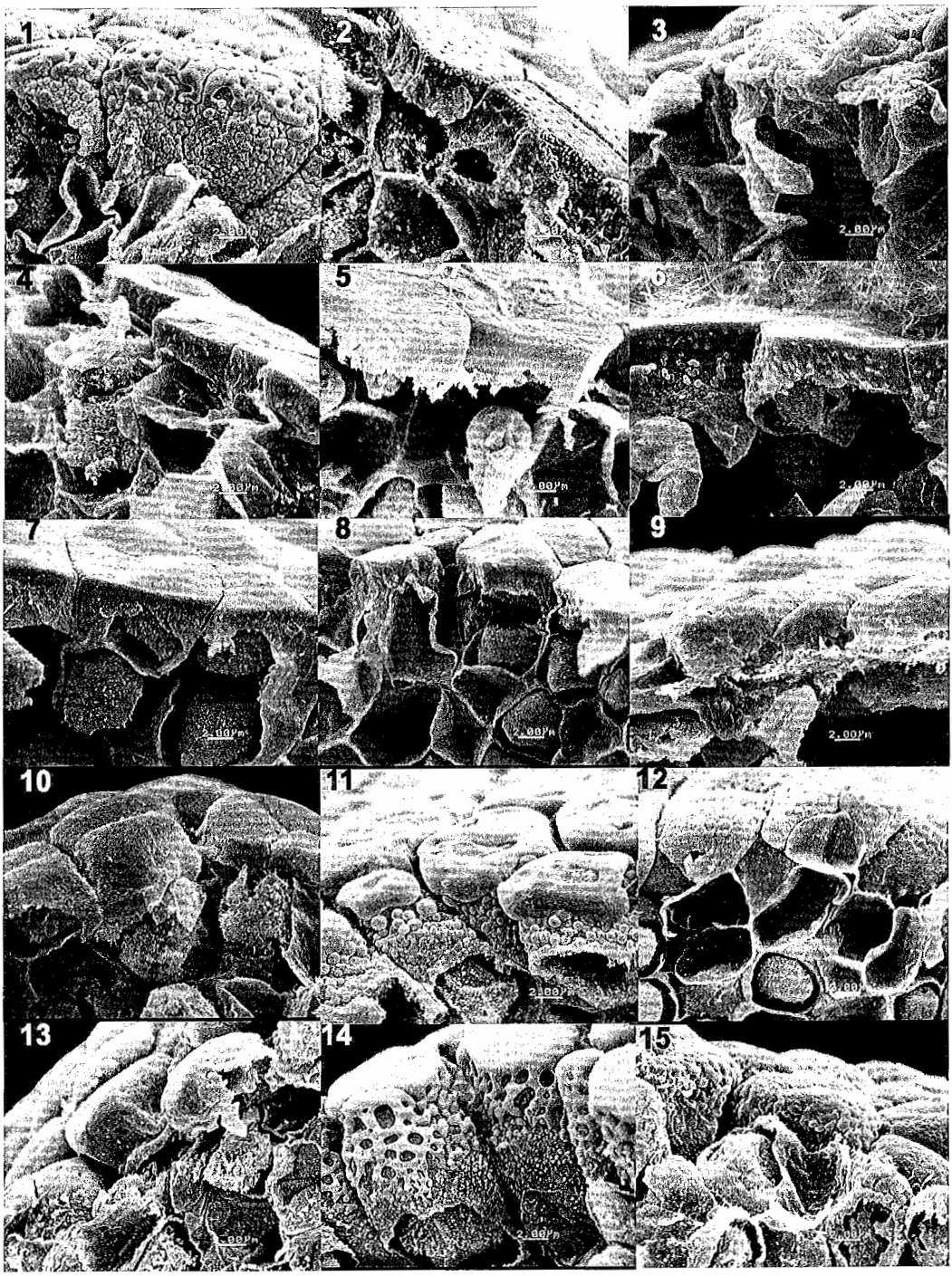

FIGURE 4c. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Pleurothallidinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of the exine layer of the interior and exterior walls of the surface tetrads of pollinia. Images augmented ×5000 and taken under conditions of high vacuum at 10–15 kV. 1) *Anathallis dolichopus,* 2) *Lepanthes acuminata* subsp. *acuminata,* 3) *Masdevallia tuerckheimii,* 4) *Pleurothallis leucantha,* 5) *Pleurothallis matudana,* 6) *Pleurothallis nelsonii,* 7) *Pleurothallis pansamalae,* 8) *Pleurothallis saccatilabia,* 9) *Specklinia fuegi,* 10) *Specklinia segregatifolia,* 11) *Stelis hymenantha,* 12) *Stelis megachlamys* subsp. *megachlamys,* 13) *Stelis tacanensis,* 14) *Stelis vespertina,* 15) *Stelis villosa.*

(*Arpophyllum medium*, *Chysis bractescens*) have 8. *Chysis bractescens* has 4 small and 4 large pollinia, similar to the structure of *Brassavola nodosa* (Nieto & Damon 2008) and both *Epidendrum cnemidophorum* and *E. sobralioides* have 2 small and 2 large pollinia, as seen for *E. stamfordianum* (Nieto & Damon 2008). The pollinia are mainly obovate to elliptical and flattened and although the most common shape is obovate, there are noticeable differences between the length:width ratios which may help to distinguish between species. The relatively narrow shape of the pollinia of *Prosthechea brassavolae* and the rounded shape of those of *Epidendrum dixorum* are distiguishing features.

Dressler (1993) affirmed that the ancestral number of pollinia per pollinarium is eight and that from there, there were independent reductions to six, four or two pollinia, indicating that *Arpophyllum medium* and *Chysis bractescens* are the least evolved species of Laeliinae in the Soconusco region, together with *Brassavola nodosa*, *Laelia rubescens* and *Meiracyllium trinasutum* mentioned in Nieto & Damon (2008).

The pollinia of *Barkeria spectabilis* have a typical Laeliinae shape, unlike *B. obovata* which has an atypical flattened, spherical form (Nieto & Damon 2008).

For all species studied, all the individual pollinia within the pollinarium share the same form and are of a similar size, except for *Chysis bractescens* and *Epidendrum cnemidophorum*, for which the pollinia are divided equally between small and large, as shown in TABLE 3. The size of the pollinia ranges from 0.51 × 0.43 mm (*Epidendrum culmiforme*) to 1.67 × 1.29 mm (large pollinia of *Chysis bractescens*).

All the species studied have pollinia with caudicles, except for *Arpophyllum medium* which has an undifferentiated hyaline mass. All the species of *Epidendrum* studied have granular, fused caudicles, and those of *E. culmiforme*, *E. dixorum*, *E. eximium* and *E. sobralioides* are also hyaline. The caudicles of *Prosthechea* are long, granular and not fused.

The pollinia of *Epidendrum cnemidophorum*, *E. culmiforme*, *E. dixorum*, *E. eximium* have a *C. Hard* 2 texture in which the majority of the tetrads break up making it impossible to measure and determine the size of the tetrads and shape of their arrangement. For those pollinia with tetrads that remain intact after fracture, sizes ranged from 25.2 × 1 3.5 (*Chysis bractescens*) to 12.7 × 13.4 μm (*Prosthechea varicosa*), and no relationship was found between the size of the pollinium and the size of the tetrad.

The shape of the tetrads of *Arpophyllum medium*, *C. bractescens*, *Epidendrum parkinsonianum*, *E. sobralioides*, *Prosthechea brassavolae* and *P. varicosa* are calymmate and wrapped in a continuous covering like a bag. The shape of the tetrads of the remaining species in this group, where determination was possible, was either rhomboidal (*Epidendrum radicans*), tetrahedral (*Prosthechea vitelina*), or a mixture of both (*Barkeria spectabilis*).

The ornamentation of the surface exine layer of the tetrads all the species studied is laevigate or scabrate, or a combination of the two, whereas the interior exine layer of most of the species are scabrate, but scabrate to laevigate for *Chysis bractescens*, and gemmate for *Epidendrum dixorum*.

The results show marked consistency in the number and form of the pollinia within and between the species of Laeliinae in this and the 2008 study, with the exception of *Arpophyllum medium* which most resembles *Laelia rubescens*, and *Chysis bractescens* which resembles *Brassavola nodosa*, both of which are shown in Nieto and Damon (2008).

Although individual species have characteristics that clearly distinguish them, it was not possible to determine characteristics that unite species at the generic level.

c. Subtribe Pleurothallidinae (*Anathallis*, *Lepanthes*, *Masdevallia*, *Pleurothallis*, *Specklinia*, *Stelis*)

The data for this group is presented in TABLE 4 and FIGURES 1c, 2c, 3c, 4c.

All the species studied of the Tribe Epidendreae have two pollinia. The pollinia of the Pleurothallidinae are small and amongst the smallest of all the orchid species found in Soconusco. The pollinaria are variable in shape, deltoid for *Anathallis*, clavate for *Lepanthes*, obovoid flattened for *Masdevallia*, clavate or obovoid flattened for *Pleurothallis* (coinciding with the forms of the unidentified species of *Pleurothallis* included in the 2008 study) deltoid or obovoid flattened for *Specklinia* and deltoid, spheroid flattened or obovoid flattened for *Stelis*.

All the species studied, except for *Specklinia fuegi* and *Masdevallia tuerckheimii*, have clearly visible accessory structures that would facilitate adherence to the pollinator; however, for those species without such structures it is possible that the entire surface of the pollinia is sticky. Stenzel (2000) describes the pollinia of the subtribe Pleurothallidinae as having undifferentiated caudicles, but we now correctly refer to the accessory structures in this subtribe, where present, as stipes. *Anathallis dolichopus*, *Specklinia segregatifolia*, *Stelis tacanensis* and *S. villosa* each have a short, granular hyaline stipe. The stipes of *Stelis hymenantha* and *S. megachlamys* subsp. *megachlamys* are also granular and short and those of *Pleurothallis matudana* and *P. saccatilabia* are

TABLE 5. Morphological and morphometric characteristics of the pollinia and tetrads of the orchid species of Subtribe Oncidiinae and Tribe Zygopetalinae (Subfamily Epidendroideae).

Orchid species	No. pollinia	Size of pollinia (mm) length	width	L/W ratio	Shape of pollinia
Tribe Cymbidiae					
Subtribe Oncidiinae					
Cyrtochiloides ochmatochila	2	1.09	0.61	1.79	obovoid
Oncidium oliganthum[R]	2	1.12	0.82	1.36	broadly ellipsoidal
Plectrophora alata	2	0.95	0.69	1.38	obovoid
Rhynchostele cordata	2	1.78	1.17	1.52	obovoid
Rhynchostele pygmaea	2	0.68	0.43	1.58	obovoid
Rhynchostele stellata[R]	2	1.03	0.57	1.80	ellipsoidal with one straight side
Rhynchostele uroskinneri[R]	2	2.00	0.92	2.17	obovoid
Rossioglossum grande	2	2.10	0.70	3.00	obovoid
Trichocentrum bicallosum[R]	2	3.60	1.53	2.35	obovoid
Tribe Zygopetalinae					
Dichaea muricatoides	2 l[a] 2 s[b]	0.95 0.75	0.63 0.54	1.51 1.39	triangular

[R] average of two repetitions.
[a] large.
[b] small.
[c] not determined.
[d] c. compact.

granular and medium sized, but none of these are hyaline. The short or medium sized granular stipes of *Lepanthes acuminata* subsp. *acuminata*, *Pleurothallis leucantha*, *Pleurothallis matudana*, *P. pansamalae* and *Stelis vespertina* also have a hyaline mass.

The texture of the pollinia of this group is *C. Hard 2*, which can be observed at the cut surface of the fractured pollinia, wherein the majority of the pollen grains are split open.

The ornamentation of the exine layer is variable, but basically very similar for all the species of *Pleurothallis* (with the exception of *P. nelsonii*). For *Specklinia fuegi* and *Stelis megachlamys* subsp. *megachlamys* both the interior and surface exine layers have a laevigate ornamentation. *P. nelsonii* also has a laevigate surface exine layer but has a scabrate interior exine layer. Another three species of *Stelis* (*S. hymenantha*, *S. vespertina* and *S. villosa*) coincide in having a laevigate (tending towards scabrate for *S. villosa*) surface exine layer but these differ in having heterobrochate interior exine layers. *S. tacanensis* can be distinguished by having a microfossulate ornamentation of both interior and surface exine layers, and *Specklinia segregatifolia* and *Masdevallia tuerckheimii* differ by having scabrate interior and surfacer exine layers (tending towards laevigate for the surface exine layer of *M. tuerckheimii*). *Aanathallis dolichopus* has fossulate and heterobrochate surface and interior exine layers, respectively. *Lepanthes acuminata* subsp. *acuminata* has microfoveolate and scabrate surface and interior exine layers, respectively.

3. *Tribe Cymbidiae*

a. Subtribe Oncidiinae (*Cyrtochiloides*, *Oncidium*, *Plectrophora*, *Rhynchostele*, *Rossioglossum*, *Trichocentrum*)

The data for this group is presented in TABLE 5 and FIGURES 1d, 2d, 3d, 4d.

All the species studied of the Tribe Cymbidiae have two pollinia and the pollinia of the species of the Oncidiinae studied are obovoid or ellipsoid, and globose due to the folding of the pollen mass, similar to many vandoid orchids, as reported by Freudenstein et al. (2002).

All of the pollinia possess a clearly visible stipe, as described by Dressler (1993) for the advanced Epidendroideae. The length of the stipe varies from 0.86 mm for *Cyrtochiloides ochmatochila* to 2.93 mm for *Rhynchostele uroskinneri*, whereas the width varies from 0.17 mm for *Rhynchostele pygmaea* to 0.56 mm *Plectrophora alata*.

The texture of the majority of the pollinia in this group is *C. Hard 1*, but the pollinia of *Cyrtochiloides ochmatochila* and *Rossioglossum grande*

TABLE 5. Extended.

Size of stipe (mm) length × width	Texture[d]	Size of tetrad (μ) length × width	Shape of tetrad	Surface tetrads	Surface exine layer	Interior exine layer
0.86 × 0.30	c. soft	15.9 × 12.9	calymmate	isometric	scabrate to laevigate	scabrate
2.12 × 0.25	c. hard 1	17.1 × 13.1	calymmate	slightly elongate	scabrate to laevigate	scabrate
1.64 × 0.56	c. hard 2	n.d.[c]	n.d.[c]	slightly elongate	microfoveolate	scabrate
1.75 × 0.39	c. hard 1	27.6 × 22.4	calymmate	elongate	scabrate to laevigate	scabrate
1.37 × 0.17	c. hard 1	23.3 × 22.6	calymmate	elongate	scabrate	scabrate
1.40 × 0.50	c. hard 1	26.6 × 19.1	calymmate	slightly elongate	scabrate to laevigate	scabrate
2.93 × 0.38	c. hard 1	21.6 × 15.2	rhomboidal	elongate	scabrate to laevigate	scabrate
1.55 × 0.48	c. soft	20.9 × 20.7	calymmate	isometric	scabrate to laevigate	scabrate
1.55 × 2.30	c. hard 1	37.4 × 19.1	calymmate	elongate	scabrate	scabrate
1.01 × 0.55	c. hard 1	18.2 × 11.9	calymmate	slightly elongate	microfoveolate	scabrate

have a compact soft texture and those of *Plectrophora alata* have a *C. Hard 2* texture, which made it impossible to determine the size and shape of the tetrads.

The tetrads of the majority of the species are wrapped in a common covering (calymmate), except for *Rhynchostele uroskinneri* which has a rhomboidal arrangement (size and shape could not be determined for *Plectrophora alata*).

The ornamentation of the interior exine layer of the tetrads of all the species of Onciidinae studied is scabrate. The ornamentation of the surface exine layer for most of the species is scabrate to laevigate, except for *Plectrophora alata* (microfoveolate), *Rhynchostele pygmaea* and *Trichocentrum bicallosum* (scabrate).

b. Subtribe Zygopetilinae (*Dichaea*)

The data for this species is presented in TABLE 5 and FIGURES 1d, 2d, 3d, 4d.

The 4 pollinia of *Dichaea muricatoides* of the Subtribe Zygopetalinae are divided into 2 small (0.75 × 0.54 mm) and 2 large (0.95 × 0.63 mm), with a stipe and a *C. Hard 1* texture. The tetrads are calymmate with microfoveolate and scabrate surface and interior exine layers, respectively.

4. *Tribe Maxillariinae* (Lycaste, Maxillaria)

5. *Tribe Stanhopeinae* (Stanhopea)

The data for this group is presented in TABLE 6 and FIGURES 1e, 2e, 3e, 4e.

All the species studied in Tribe Maxillariinae have 4 pollinia per pollinarium and these are divided into 2 smaller and 2 larger pollinia per pollinarium, although the difference in size is slight for *Lycaste* sp., *Lycaste cruenta*, and *Maxillaria houtteana*. The forms and sizes of the pollinaria are similar, with the largest pollinia belonging to *Maxillaria meleagris* and *M. soconuscana*, All the pollinia have an ellipsoidal or spherical flattened shape. The Tribe Stanhopeinae, represented by *Stanhopea graveolens*, has 2 pollinia with a narrowly ellipsoidal shape, as seen for *Stanhopea saccata* (Nieto & Damon, 2008). It should be mentioned here that the plants and flowers for *Lycaste* sp. and *L. cruenta* are very similar, except for the much larger size of *Lycaste* sp. However, the characteristics of the pollinaria are notably different and for that reason are mentioned separately.

The accessory structures of the Maxillariinae are varied, but all the species in this study have a stipe, with *Maxillaria houtteana* having the largest stipe and in the form of an arch (referred to as "an arch-shaped viscidia" in Nieto & Damon 2008). For the Stanhopeinae, *Stanhopea graveolens* also has a stipe, but it is much longer than those of the Maxillariinae.

The texture of the pollinia of *Maxillaria* is soft compact, as found for those species included in Nieto & Damon (2008), except for *Maxillaria atrata* which has *C. Hard 1* texture. The pollinia of *Lycaste* sp. and *L. cruenta* also have a *C. Hard 1* texture and the pollinia of *Stanhopea graveolens* has a *C. Hard 2* texture.

The tetrads of *Lycaste* sp., *Maxillaria atrata*, *M. meleagris* and *M. soconuscana* are enveloped by a

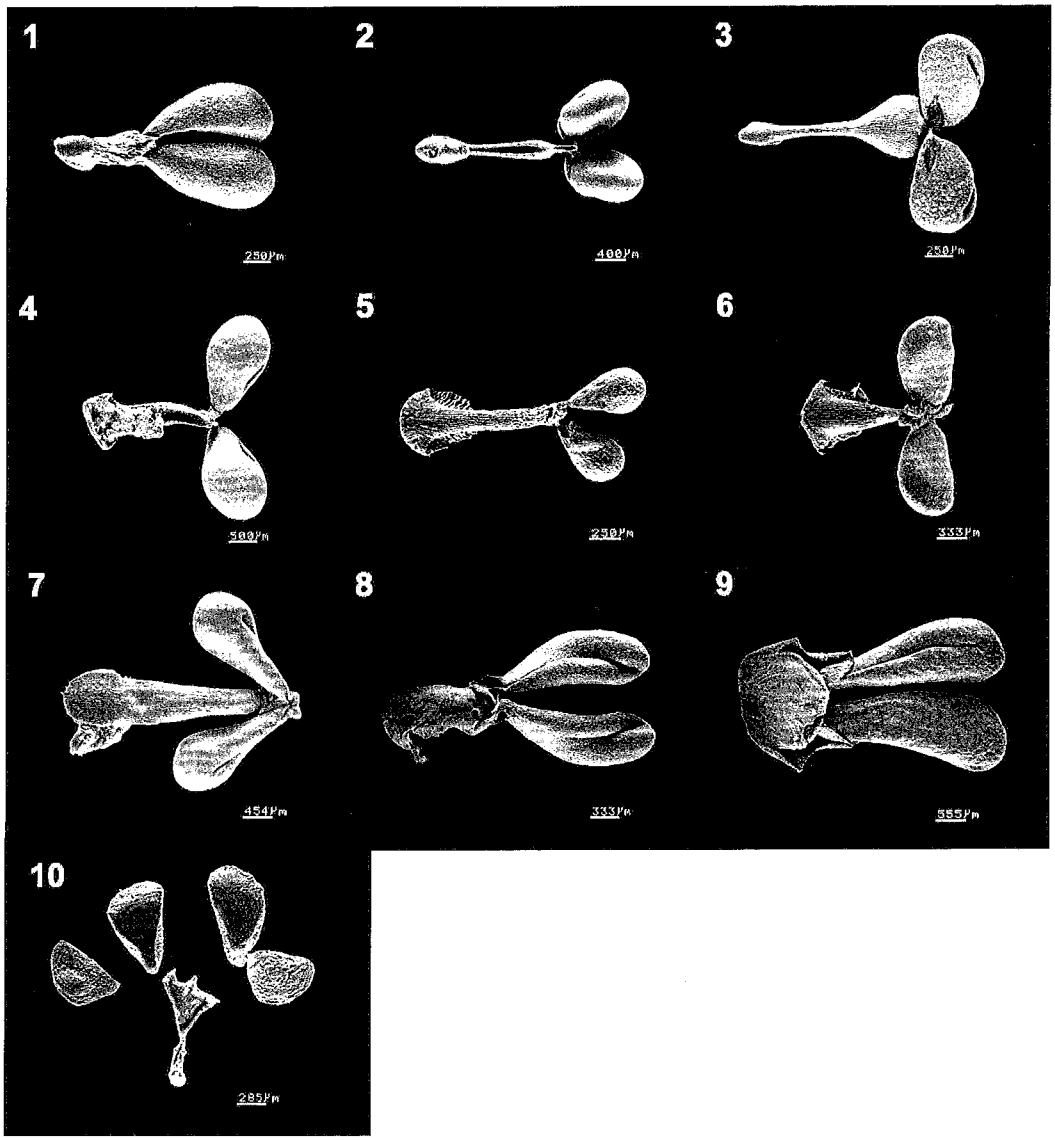

FIGURE 1d. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Oncidiinae and Tribe Zygopetalinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of fresh, entire, unprocessed pollinia. Images taken under conditions of low vacuum at 25–30 kV. 1) *Cyrtochiloides ochmatochila,* 2) *Oncidium oliganthum,* 3) *Plectrophora alata,* 4) *Rhynchostele cordata,* 5) *Rhynchostele pygmaea,* 6) *Rhynchostele stellata,* 7) *Rhynchostele uroskinneri,* 8) *Rossioglossum grande,* 9) *Trichocentrum bicallosum,* 10) *Dichaea muricatoides.*

common covering (calymmate) whereas the rhomboidal arrangement of *M. houtteana* is visible. Due to their hard texture, the shape of the tetrads of *Lycaste cruenta* and *Stanhopea graveolens* could not be determined.

The ornamentation of the exine layer of all the species of *Maxillaria* studied is laevigate to scabrate or vice versa, on both the surface and the interior of the tetrads.

Subfamily Vandeae

1. *Tribe Angraecinae (*Campylocentrum*)*

The data for this species is presented in TABLE 6 and FIGURES 1e, 2e, 3e, 4e.

The pollinia of *Campylocentrum microphylum* are broadly ellipsoidal, whereas those of *C. micranthum* (Nieto & Damon, 2008) are spherical and both have a *C. Hard 1* texture. *C. micro-*

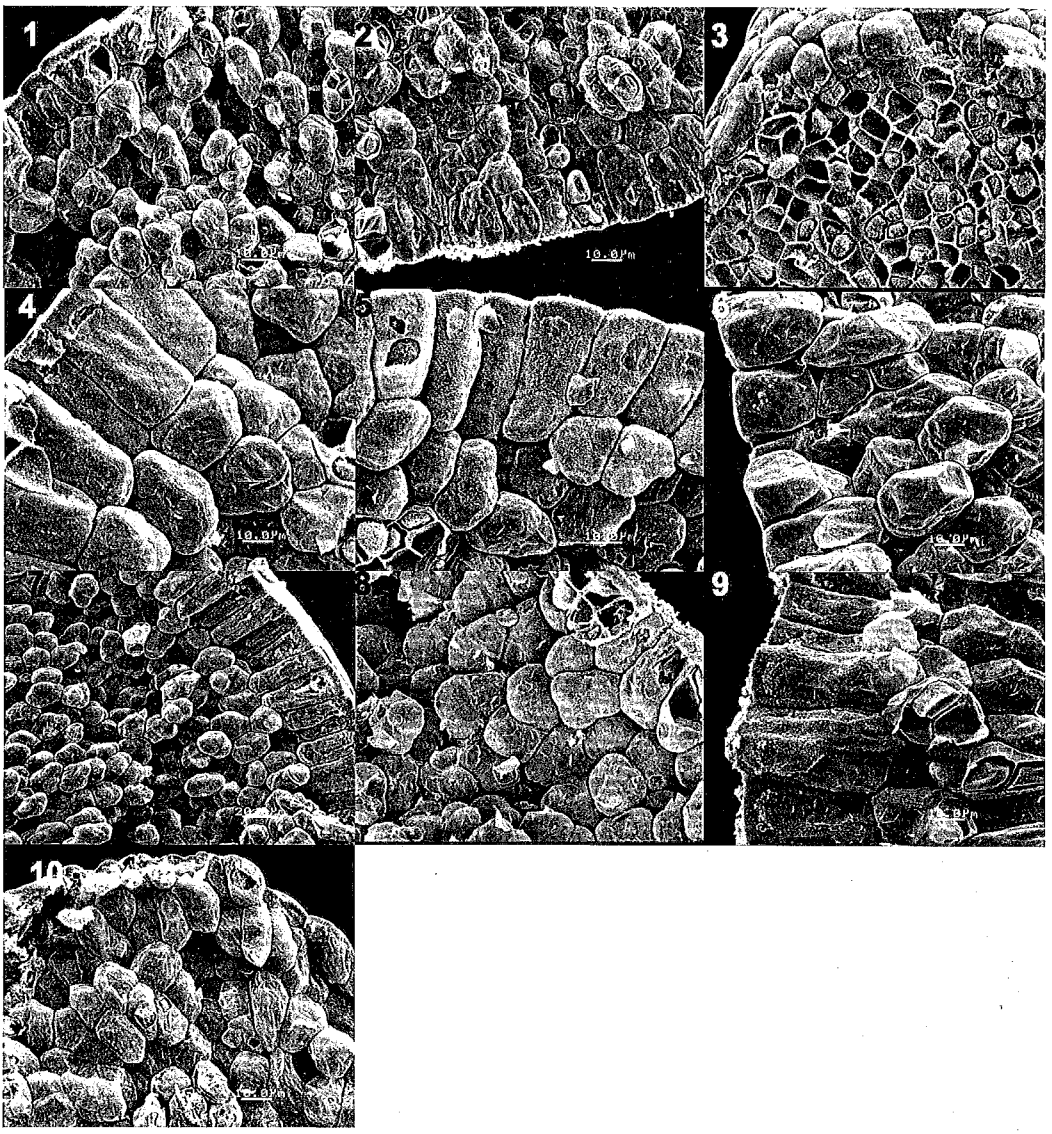

FIGURE 2d. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Oncidiinae and Tribe Zygopetalinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of the tetrads towards the interior of the pollinia, after processing and dry-fracture. Images augmented ×1000 and taken under conditions of high vacuum at 10–15 kV. 1) *Cyrtochiloides ochmatochila,* 2) *Oncidium oliganthum,* 3) *Plectrophora alata,* 4) *Rhynchostele cordata,* 5) *Rhynchostele pygmaea,* 6) *Rhynchostele stellata,* 7) *Rhynchostele uroskinneri,* 8) *Rossioglossum grande,* 9) *Trichocentrum bicallosum,* 10) *Dichaea muricatoides.*

phyllum has two stipes, one (0.37 mm), far larger than the other (0.09 mm).

ACKNOWLEDGEMENTS

We are grateful for the financial support of CONACyT-FOMIX-CHIAPAS (CHIS-2006-C06-45802. 2007–2010: Project "Diversidad y conservación de las orquídeas del corredor biológico Tacaná-Boquerón"). We thank Rodolfo Solano, Laura Jiménez Bautista, Gabriela Cruz Lustre, Socorro Vásquez Avendaño and Nelson Pérez Miguel for their enthusiastic and fruitful participation in the project.

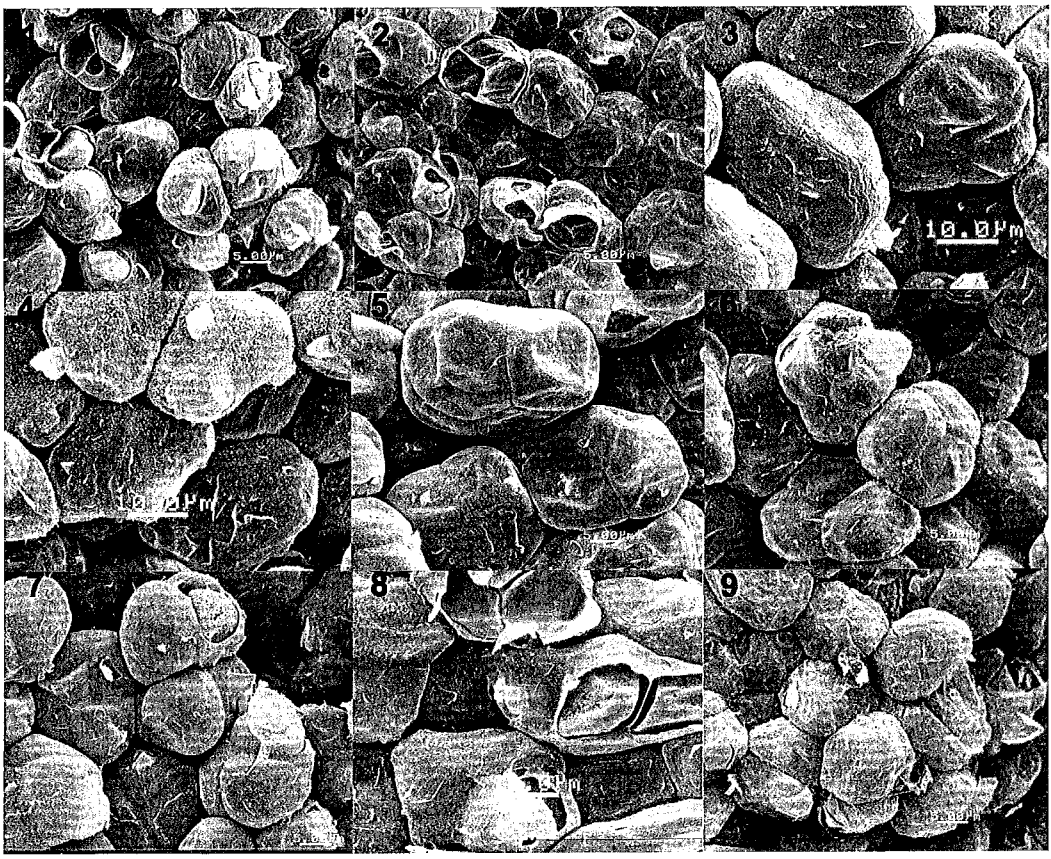

FIGURE 3d. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Oncidiinae and Tribe Zygopetalinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of the tetrads towards the interior of the pollinia, after processing and dry-fracture. Images augmented ×2000 and taken under conditions of high vacuum at 10–15 kV. 1) *Cyrtochiloides ochmatochila,* 2) *Oncidium oliganthum,* 3) *Rhynchostele cordata,* 4) *Rhynchostele pygmaea,* 5) *Rhynchostele stellata,* 6) *Rhynchostele uroskinneri,* 7) *Rossioglossum grande,* 8) *Trichocentrum bicallosum,* 9) *Dichaea muricatoides.*

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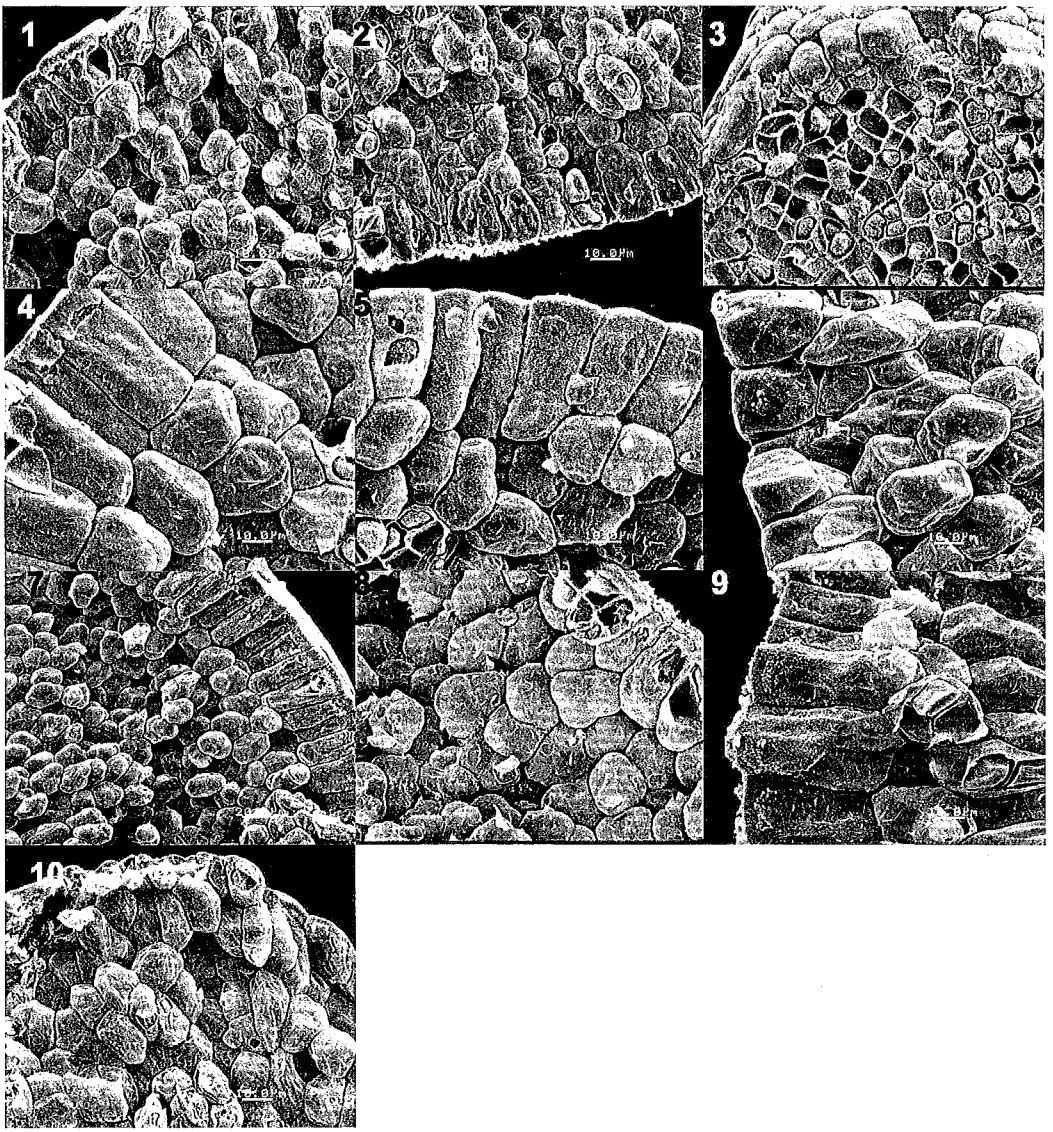

FIGURE 4d. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Subtribe Oncidiinae and Tribe Zygopetalinae (Subfamily Epidendroideae): Photographs of images taken by a scanning electron microscope of the exine layer of the interior and exterior walls of the surface tetrads of pollinia. Images augmented ×5000 and taken under conditions of high vacuum at 10–15 kV. 1) *Cyrtochiloides ochmatochila,* 2) *Oncidium oliganthum,* 3) *Plectrophora alata,* 4) *Rhynchostele cordata,* 5) *Rhynchostele pygmaea,* 6) *Rhynchostele stellata,* 7) *Rhynchostele uroskinneri,* 8) *Rossioglossum grande,* 9) *Trichocentrum bicallosum,* 10) *Dichaea muricatoides.*

TABLE 6. Morphological and morphometric characteristics of the pollinia and tetrads of the orchid species of Tribes Maxillariinae and Stanhopeinae (Subfamily Epidendroideae) and Tribe Angraecinae (Subfamily Vandeae).

Orchid species	No. pollinia	Size of Pollinia (mm) length	width	L/W ratio	Shape of pollinia
Tribe Maxillariinae					
Lycaste sp.	2 l[a] 2 s[b]	1.39	0.98	1.4	ellipsoidal, flattened
		1.14	0.85	1.34	
Lycaste cruenta	2 l[a] 2 s[b]	1.21	0.80	1.51	ellipsoidal, flattened
		1.12	0.72	1.56	
Maxillaria atrata[R]	2 l[a] 2 s[b]	1.33	1.11	1.20	spheroid, flattened
		0.97	0.93	1.04	
Maxillaria houtteana	2 l[a] 2 s[b]	1.96	1.22	1.61	ellipsoidal, flattened
		1.83	1.02	1.79	
Maxillaria meleagris	2 l[a] 2 s[b]	1.20	1.37	0.88	spheroid, flattened
		1.06	1.15	0.92	
Maxillaria soconuscana	2 l[a] 2 s[b]	1.48	1.34	1.10	spheroid, flattened
		1.20	1.08	1.11	
Tribe Stanhopeinae					
Stanhopea graveolens	2	3.98	1.11	3.58	narrowly ellipsoidal
Tribe Angraecinae					
Campylocentrum microphyllum	2	0.17	0.13	1.30	broadly ellipsoidal

[R] average of two repetitions.
[a] large.
[b] small.
[c] not determined.
[d] c. compact.

TABLE 6. Extended.

Size of stipe (mm) length × width	Texture[d]	Size of tetrad (μ) length × width	Shape of tetrad	Surface tetrads	Surface exine layer	Interior exine layer
2.39 × 0.40	c. hard 1	12.9 × 10.7	calymmate	slightly elongate	scabrate to laevigate	scabrate to laevigate
1.30 × 0.42	c. hard 1	n.d.[c]	n.d.[c]	slightly elongate	granular	granular
0.70 × 0.66	c. hard 1	20.2 × 16.0	calymmate	isometric	laevigate to scabrate	laevigate to scabrate
3.50 × 2.80	c. soft	27.3 × 21.1	rhomboidal	isometric	scabrate to laevigate	scabrate to laevigate
1.09 × 0.96	c. soft	21.4 × 15.6	calymmate	isometric	scabrate to laevigate	scabrate to laevigate
1.31 × 1.10	c. soft	19.4 × 15.9	calymmate	isometric	scabrate	scabrate
3.35 × 0.75	c. hard 2	n. d.[c]	n. d.[c]	isometric	microfossulate	granular
two stipes 0.37 × 0.09	c. hard 2	n. d.[c]	n. d.[c]	isometric	laevigate	laevigate

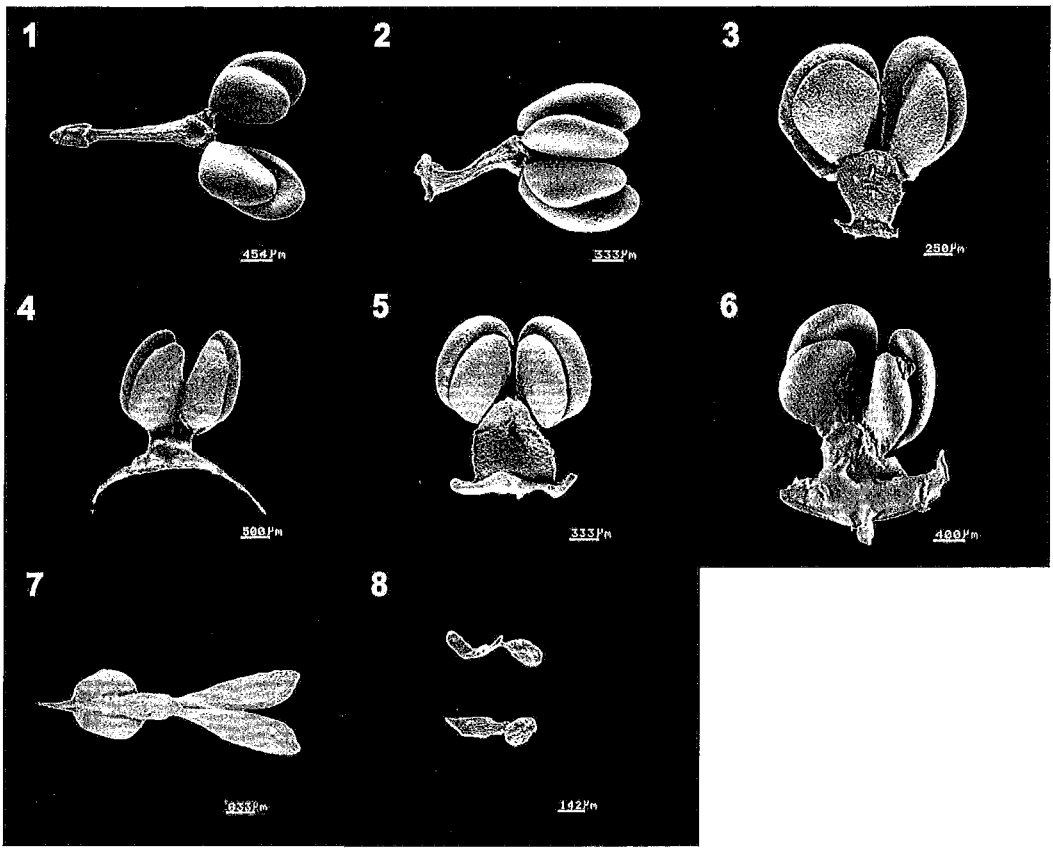

FIGURE 1e. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Tribe Maxillariinae (Subfamily Epidendroideae) and Tribe Angraecinae (Subfamily Vandae): Photographs of images taken by a scanning electron microscope of fresh, entire, unprocessed pollinia. Images taken under conditions of low vacuum at 25–30 kV. 1) *Lycaste* sp., 2) *Lycaste cruenta,* 3) *Maxillaria atrata,* 4) *Maxillaria houtteana,* 5) *Maxillaria meleagris,* 6) *Maxillaria soconuscana,* 7) *Stanhopea graveolens,* 8) *Campylocentrum microphyllum.*

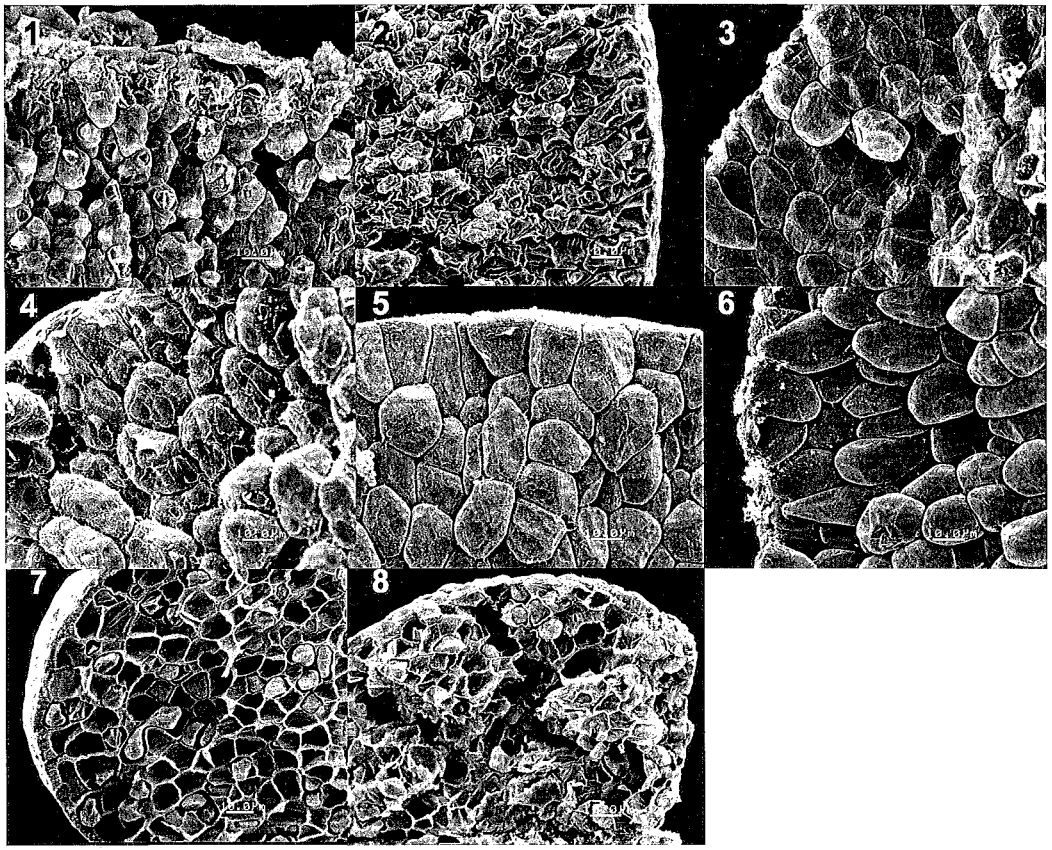

FIGURE 2e. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Tribe Maxillariinae (Subfamily Epidendroideae) and Tribe Angraecinae (Subfamily Vandae): Photographs of images taken by a scanning electron microscope of the tetrads towards the interior of the pollinia, after processing and dry-fracture. Images augmented ×1000 and taken under conditions of high vacuum at 10–15 kV. 1) *Lycaste* sp., 2) *Lycaste cruenta,* 3) *Maxillaria atrata,* 4) *Maxillaria houtteana,* 5) *Maxillaria meleagris,* 6) *Maxillaria soconuscana,* 7) *Stanhopea graveolens,* 8) *Campylocentrum microphyllum.*

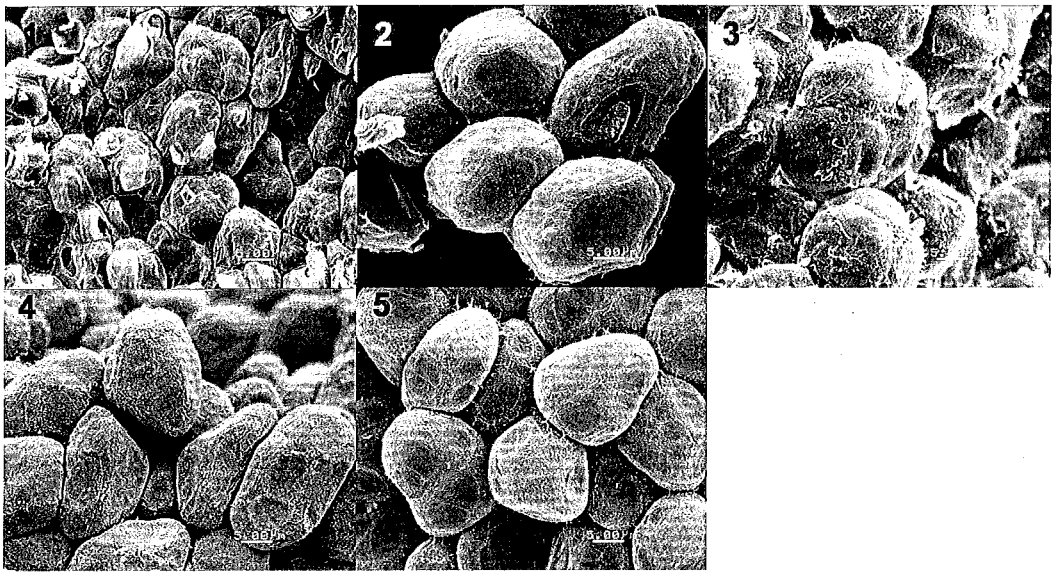

FIGURE 3e. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Tribe Maxillariinae (Subfamily Epidendroideae) and Tribe Angraecinae (Subfamily Vandae): Photographs of images taken by a scanning electron microscope of the tetrads towards the interior of the pollinia, after processing and dry-fracture. Images augmented ×2000 and taken under conditions of high vacuum at 10–15 kV. 1) *Lycaste* sp., 2) *Maxillaria atrata,* 3) *Maxillaria houtteana,* 4) *Maxillaria meleagris,* 5) *Maxillaria soconuscana.*

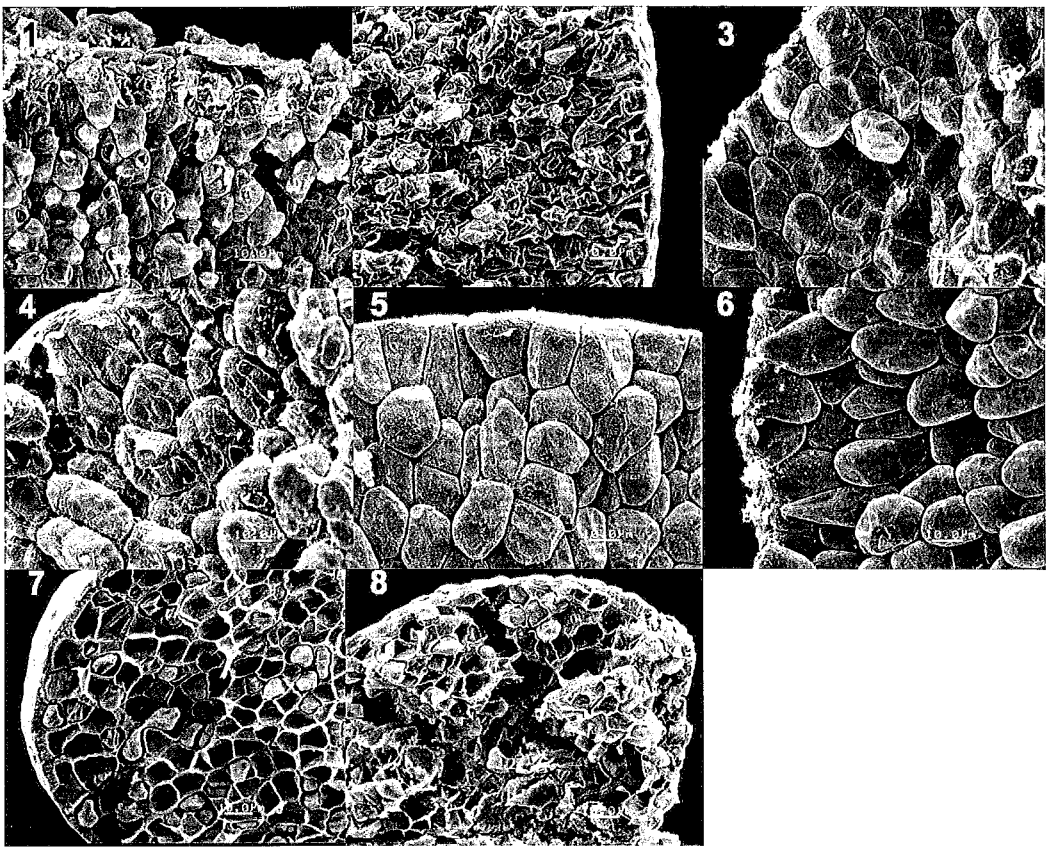

FIGURE 4e. Orchids from the biological corridor Tacaná-Boquerón, in southeast Mexico from the Tribe Maxillariinae (Subfamily Epidendroideae) and Tribe Angraecinae (Subfamily Vandae): Photographs of images taken by a scanning electron microscope of the exine layer of the interior and exterior walls of the surface tetrads of pollinia. Images augmented ×5000 and taken under conditions of high vacuum at 10–15 kV. 1) *Lycaste* sp., 2) *Lycaste cruenta,* 3) *Maxillaria atrata,* 4) *Maxillaria houtteana,* 5) *Maxillaria meleagris,* 6) *Maxillaria soconuscana,* 7) *Stanhopea graveolens,* 8) *Campylocentrum microphyllum.*

Selbyana 31(1): 40–43. 2013.

A New Name for a Distinctive *Rhynchostylis* (Orchidaceae) and The Misapplication of *Rhynchostylis praemorsa*

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Abstract. The genus *Rhynchostylis* has three currently accepted species. The name *Rhynchostylis praemorsa* Willd. has been misapplied to a Philippine species. This attractive forth species is named and described. A dichotomous key to *Rhynchostylis* is provided.

Key words: Epidendroideae, Vandeae, Aeridinae, nomenclature, taxonomy, key

Introduction

When Carl Ludwig von Blume described the genus *Rhynchostylis* (*Rynchostylis*) in 1825, he included two species *Rhynchostylis retusa* Blume and *R. praemorsa* Blume. Carl Blume listed *Aerides retusa* (L.) Sw. as a synonym of *Rhynchostylis retusa* and *Aerides praemorsa* Willd. as a synonym of *R. praemorsa.* Both species were described as growing on trees in *Bantam et Buitenzorg* (Java). The differences stated by Blume between the two species are the month of flowering and the leaf apex. *Rhynchostylis retusa* has a bifid retuse apex and flowers in February while *Rhynchostylis praemorsa* has an oblique praemorsis (bitten off) apex and flowers in April. Java experiences two distinct seasons; the rainy season from October to April, and the dry season from May to September.

When Olof Swartz treated *Aerides retusum (=R. retusa)* in 1799(a), he stated that the habitat was in Malabaria. Swartz also listed as synonyms his *Limodorum retusum* Sw. (1799b) and *Epidendrum retusum* L. (Linnaeus 1753) [miscited as Rheed Mal. 12. Tab. 1]. Linnaeus states that India is the habitat for *Epidendrum retusum* L. Carl Linnaeus also lists *Anjeli Maravara* Rheede, and *Biti Maram Maravara* Rheede, (Rheede 1693) as synonyms. Hendrik Adriaan von Rheede states that both species are found growing epiphytically in Malabar.

When Carl Ludwig von Willdenow described *Aerides praemorsa* in 1805 he stated that the species was from west India. He also listed *Biti Maram Maravara* Rheede from Malabar as a synonym. The Malabar Coast of India (southwestern lowlands) has a humid tropical wet monsoon climate. Most rainfall occurs between May and November. December to March represent the driest months when precipitation is rare.

It is clear that the World Checklist of Selected Plant Families is correct that *Rhynchostylis retusa* and *R. praemorsa* are the same species or at most different forms of the same species. The leaf apex of *Rhynchostylis retusa* is highly variable and flowering period is influenced by climatic conditions. The species occurs in semi-deciduous and deciduous dry lowland forests woodlands at elevations of sea level to 700 m; it is native to India, Malaya, Singapore, Sri Lanka, and Thailand.

Another species from the Philippines has been called *Rhynchostylis praemorsa* by orchidologists for many years. An image of the plant can be found on page 170 of *The Orchids of the Philippines* (Cootes, Banks, and Titmuss 2001). What name could apply to this entity? The previous epithets in *Rhynchostylis* have been misapplied and are unavailable for various reasons.

Discussion

There are currently three recognized *Rhynchostylis* species, *R. coelestis* Rchb.f. ex A.H.Kent, *R. retuse,* R. *gigantea* (Lindl.) Ridl., and two subspecies *R. gigantea* subsp. *gigantea, R. gigantea* subsp. *violacea* (Lindl.) Christenson (World Checklist of Selected Plant Families 2012). In July 2009, Robert Riefer flowered a plant that he had purchased at the Miami International Orchid Show from Mac's Orchids (Fort Lauderdale) the previous year as *Rhynchostylis praemorsa* Blume which is a synonym of *R. retusa* (L.) Blume. This plant from the Philippines has several distinct characteristics that distinguish it from *R. retusa* (Table 1). The leaf tips are sub-oblique with the central vein extending into a small sharp acute point, and the flowers are smaller. The labellum is narrow with a small sharp upturned and hook-like apicule at the apex and the mentum or spur also has a distinctive shape.

Taxonomic Treatment

Rhynchostylis rieferii W.E.Higgins, sp. nov. TYPE: Ex hort.—July 2009, *R. Riefer s.n.* (Holotype: SEL). Figures 1, 2.